# User's Manual
# V3.6

Micriμm
Press

Weston, FL 33326

Micriμm
1290 Weston Road, Suite 306
Weston, FL 33326
USA

www.micrium.com

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Chapter

# 1

# Introduction

µC/Probe is a Windows application designed to read and write the memory of any embedded target processor during run-time. Memory locations are mapped to a set of virtual controls and indicators placed on a dashboard. Figure 1-1 shows an overview of the system and data flow.

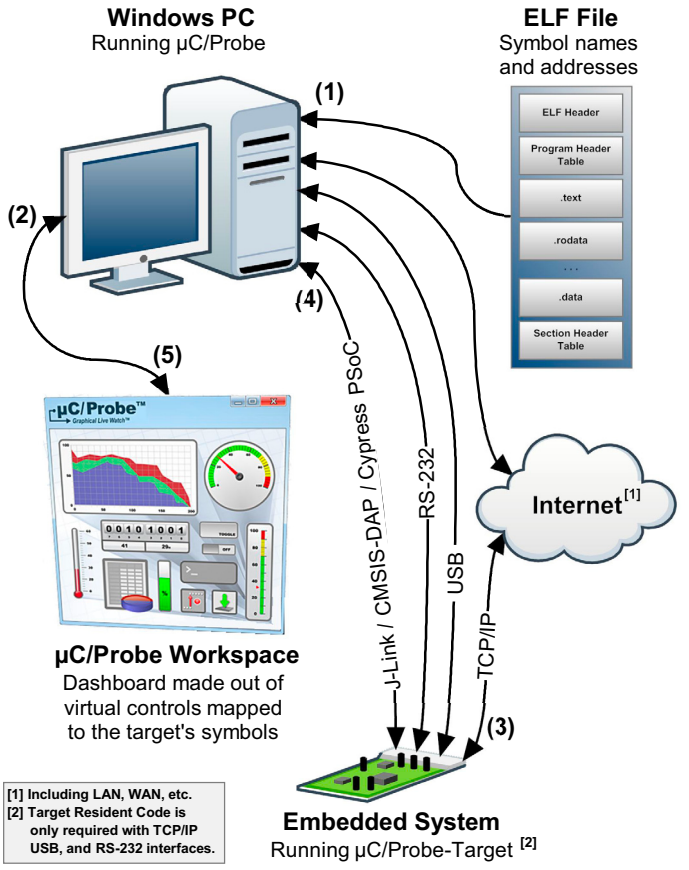



Figure 1-1 **µC/Probe Data Flow Diagram**

F1-1(1) You have to provide µC/Probe with an ELF file with DWARF-2, -3 or -4 debugging information. The ELF file is generated by your toolchain's linker. µC/Probe parses the ELF file and reads the addresses of each of the embedded target's symbols (i.e. global variables) and creates a catalog known as *symbol browser*, which will be used by you during design-time to select the symbols you want to display on your dashboard. Refer to the document µC/Probe Target Manual for more information on installing the µC/Probe Target C files and building the ELF file.

Alternatively, you can also provide a chip definition file that contains the chip's peripheral register addresses or provide your own custom XML based symbol file for those cases when your toolchain cannot generate one of the supported ELF formats.

F1-1(2) During design-time, you create a µC/Probe workspace using a Windows PC and µC/Probe. You design your own dashboard by dragging and dropping virtual controls and indicators onto a *data screen*. Each virtual control and indicator needs to be mapped to an embedded target's symbol by selecting it from the symbol browser. This document aims at providing more information on creating your own dashboard with µC/Probe.

F1-1(3) Before proceeding to the run-time stage, µC/Probe needs to be configured to use one of the following communication interfaces: J-Link, CMSIS-DAP, Cypress PSoC Prog, USB, RS-232 or TCP/IP. In order to start the run-time stage, you click the *Run* button and µC/Probe starts making requests to read the value of all the memory locations associated with each virtual control and indicator (i.e. buttons and gauges respectively). At the same time, µC/Probe sends commands to write the memory locations associated with each virtual control (i.e. buttons on a click event).

F1-1(4) In the case of a reading request, the embedded target responds with the latest value. In the case of a write command, the embedded target responds with an acknowledgement. Refer to the document µC/Probe Target Manual for more information on all you need in regards to the firmware that implements the communication interface that runs on the embedded target.

F1-1(5) µC/Probe parses the responses from the embedded target and updates the virtual controls and indicators.

In case the communication of your choice is USB, RS-232 or TCP/IP, refer to the document µC/Probe Target Manual for more information about the firmware that resides on the Embedded System.

This document only provides information about the Windows PC side of the system.

Chapter

# 2

# µC/Probe System Overview

This section provides an overview of the µC/Probe Windows Application.

Whenever you start µC/Probe in your Windows PC, three different modules are started: µC/Probe Automatic Updates and Licensing System, µC/Probe Data Client and µC/Probe Generic Target Communications Module as illustrated in Figure 2-1:

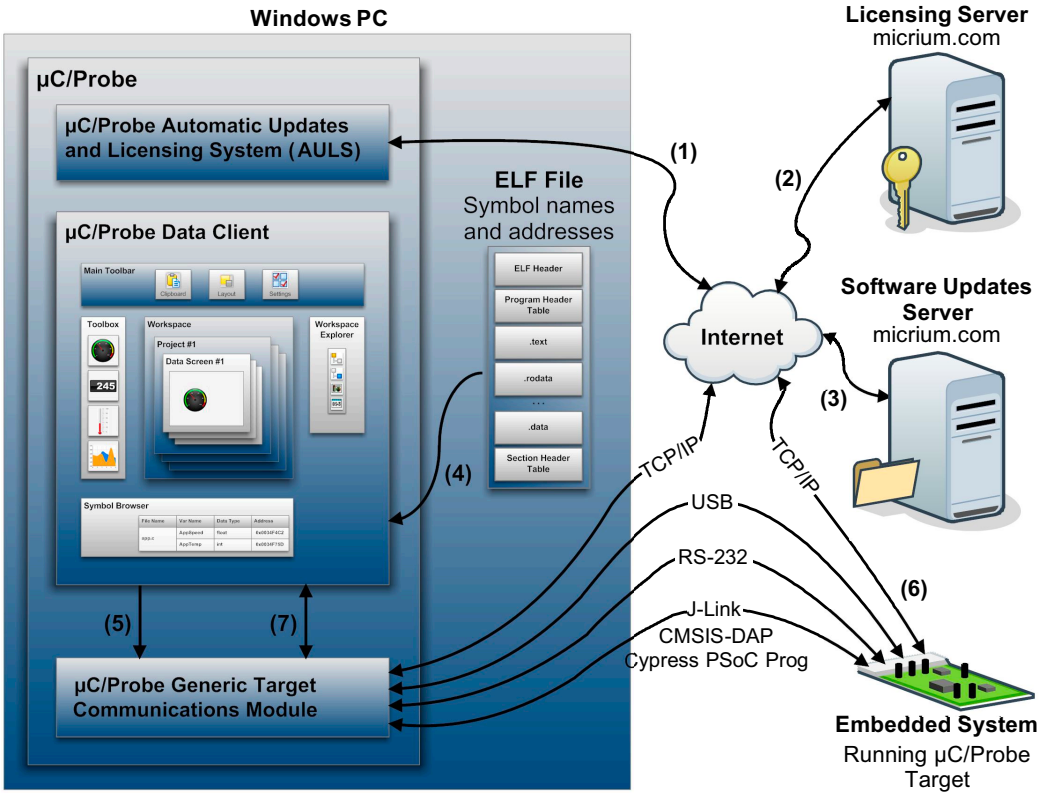



Figure 2-1 **µC/Probe System Overview**

F2-1(1) The Automatic Updates and Licensing System (AULS) is the part of the application that allows you to install and keep your µC/Probe application up to date.

F2-1(2) The Educational Edition of µC/Probe is deployed with some of the Basic and Professional Editions' features and do not require internet access to activate the software application. The Basic and Professional Edition of µC/Probe require internet access to validate the license key provided by your Micriμm's sales representative.

For more information on µC/Probe Licensing see Appendix I, "Licensing" on page 146.

F2-1(3) All Editions of µC/Probe are self-updating and every time you start the application, if internet access is available, the µC/Probe AULS module checks for newer versions of µC/Probe from the Micriμm website and as they become available, the µC/Probe AULS module, automatically replaces any updated files.

F2-1(4) The µC/Probe Data Client is the part of the application that allows you to design your dashboard (design-time mode) and run it (run-time mode).

The next section in this document provides more information in regards to using the µC/Probe Data Client during design-time and run-time.

F2-1(5) The µC/Probe Generic Target Communications Module is the part of the application that connects directly with the Embedded Target and responds to the requests from the Data Client.

When the µC/Probe run-time mode gets started, the Data Client sends requests to the Generic Target Communications Module. The requests contain not only the embedded target communication settings but also all the symbol's memory address required by your dashboard design.

F2-1(6) The Generic Target Communications Module takes the request from the µC/Probe Data Client and initiates a communication with the embedded target through the configured communication interface.

F2-1(7) The µC/Probe Data Client exchanges requests to read and write the memory locations required by the current view of your dashboard's design with the embedded target through the Generic Target Communications Module.

## 2-1 µC/PROBE DATA CLIENT

The µC/Probe Data Client is illustrated in more detail in Figure 2-2:

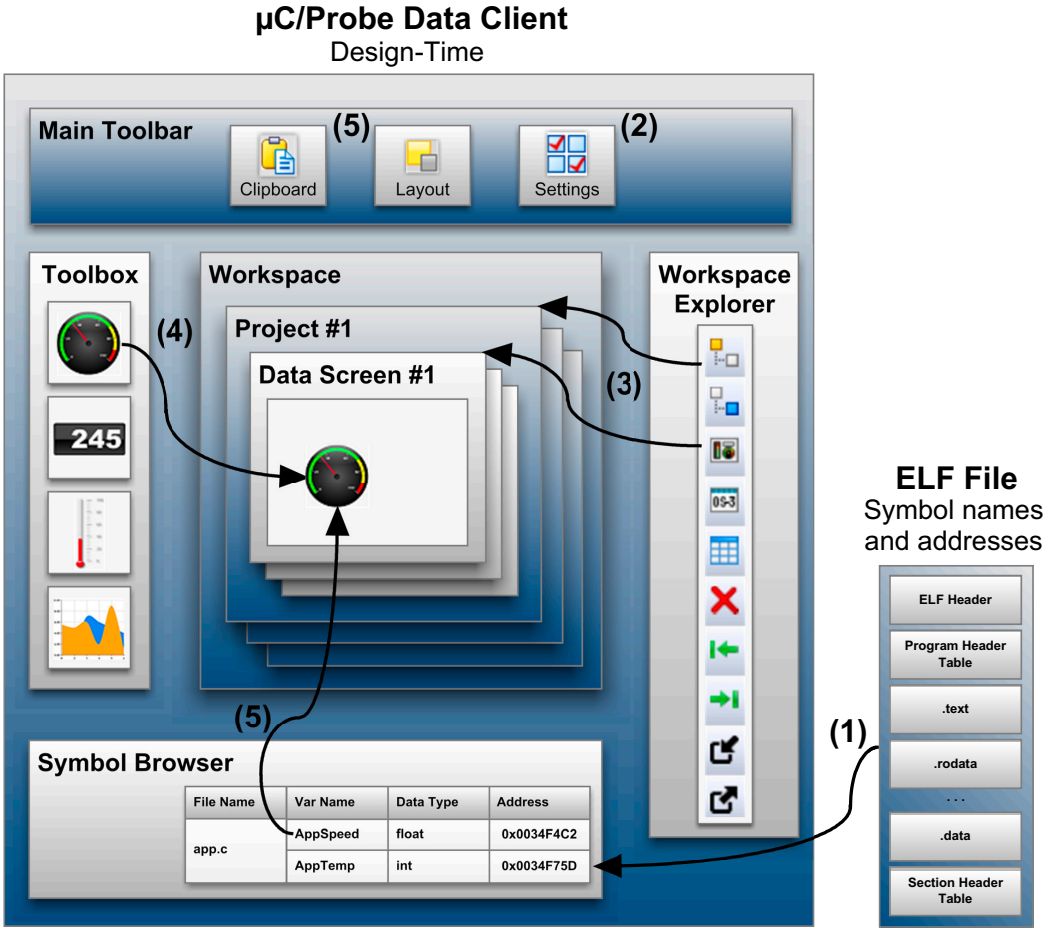



Figure 2-2 **µC/Probe Data Client: Design Time**

F2-2(1) The µC/Probe Data Client is the part of the application that during design-time takes the ELF file with DWARF-2, -3 or -4 debugging information. As previously discussed, the ELF file is generated by your toolchain's linker. The µC/Probe Data Client parses the ELF file and reads the addresses of each of the embedded target's symbols (i.e. global variables) and creates a catalog known as symbol browser, which will be used by you during design-time to select the symbols you want to display on your dashboard. Refer to the document µC/Probe Target Manual for more information on installing the µC/Probe Target C files and building the ELF file.

For more information, see Chapter 3, "µC/Probe Symbol Browser" on page 15.

F2-2(2) During design-time it is necessary to adjust the communication and other general settings. See Chapter 4, "µC/Probe Settings" on page 30 for more information on configuring µC/Probe.

F2-2(3) The Workspace Explorer in the µC/Probe Data Client allows you to add or delete Projects and Data Screens among other things.

For more information, see Chapter 5, "µC/Probe Workspace Explorer" on page 46.

F2-2(4) The µC/Probe Toolbox displays icons for the virtual controls and indicators that you can add to your Data Screens. Each toolbox icon can be dragged and dropped onto the Data Screen to build your own dashboard.

For more information, see Chapter 6, "µC/Probe Toolbox" on page 49.

F2-2(5) The µC/Probe Layout Design Tools help you arrange the virtual controls and indicators on your data screen by speeding up the creation of your dashboard and making it look great.

For more information, see Chapter 7, "µC/Probe Layout Design Tools" on page 56.

F2-2(6) The last step during design-time is to map each virtual control and indicator in your Data Screen with an Embedded Target's memory location. The symbol browser allows you to quickly find the variable you want to display and then all you have to do is drag the variable from the symbol browser and drop it onto the virtual control or indicator of your choice.

See Chapter 8, "Associating Symbols to Virtual Controls and Indicators" on page 59 for more information on using the symbol browser to map virtual controls and indicators to the embedded target's memory locations.

The actual µC/Probe windows application is shown in Figure 2-3:

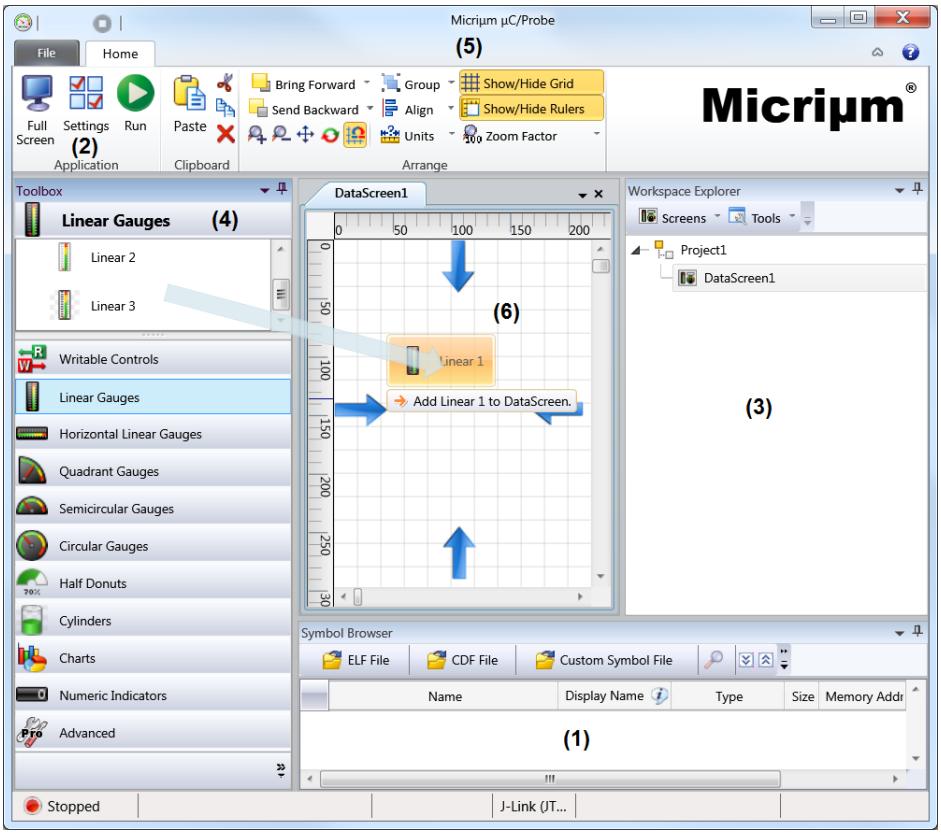



Figure 2-3 **µC/Probe Windows Application**

F2-3(1) Chapter 3, "µC/Probe Symbol Browser" on page 15.

F2-3(2) Chapter 4, “µC/Probe Settings” on page 30.

F2-3(3) Chapter 5, “µC/Probe Workspace Explorer” on page 46.

F2-3(4) Chapter 6, “µC/Probe Toolbox” on page 49.

F2-3(5) Chapter 7, “µC/Probe Layout Design Tools” on page 56.

F2-3(6) Chapter 8, “Associating Symbols to Virtual Controls and Indicators” on page 59.

Chapter

# 3

# µC/Probe Symbol Browser

The µC/Probe's Symbol Browser is a list of your embedded target's symbols that helps you quickly find the symbol you want to use in your data screen. The symbol browser is available during design-mode and it is located at the bottom of the application window.

There are four types of symbol files supported by µC/Probe's parser:

- ELF (Executable and Linkable Format).
- CDF (Chip Definition File).
- CSF (Custom Symbol File).
- MQTT Configuration File (Message Queueing Telemetry Transport).

To load any of these files, you start by clicking one or more of the buttons indicated in Figure 3-1:

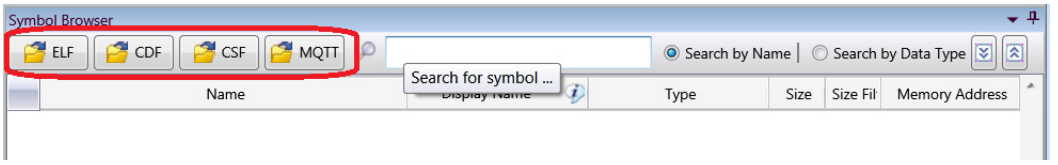



Figure 3-1 **µC/Probe Symbol Browser: Loading a symbols file**

The following sections will describe each of the four types of symbol files supported by µC/Probe. Keep in mind that you only require to load at least one of the following files.

# 3-1 ELF FILE

This file is the output from your compiling and linking process. It contains the name, data type and address of all your global variables.

## 3-1-1 LOADING AN ELF FILE

In order to provide µC/Probe with the path of the embedded target's output file (ELF file), locate and click the button labeled *ELF File* indicated in Figure 3-1.

µC/Probe will prompt for the ELF file path by using a standard open file dialog. Locate the output file in your PC. The path is usually configured from your toolchain's linker configuration.

The ELF file needs to have symbolic information for debugging purposes in the DWARF-2, -3 or -4 format.

## 3-1-2 BROWSING THE ELF FILE

µC/Probe parses the ELF file and creates a catalog that you can browse to search for the symbol you need. The symbol browser is a five-column tree list of symbols grouped by the C file name where the variable was declared as shown in Figure 3-2:

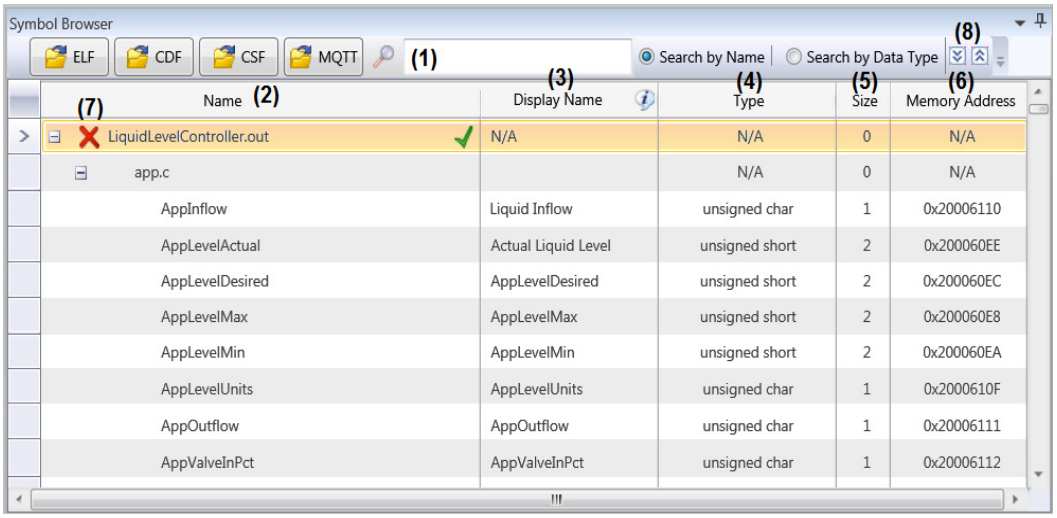



Figure 3-2 **µC/Probe Symbol Browser: Symbols grouped by C file**

F3-2(1) The symbol browser allows you to quickly find the symbol you want. Click on the symbol browser headers row to sort the list by the column you want. You can also expand and collapse tree nodes to focus on a particular C file, or you can use the search box and search by symbol name or data type.

F3-2(2) The **Name** column shows the name of the symbol as declared in your C file.

F3-2(3) The **Display Name** column by default displays the name of the symbol as declared in your C file, but also allows you to create an alias for the symbol. Double-click over the Display Name cell to create an alias.

F3-2(4) The **Type** column displays the symbol's C data type.

F3-2(5) The **Size** column displays the size in bytes of the symbol.

F3-2(6) The **Memory Address** column displays the symbol's location in the embedded target's memory.

F3-2(7) Click on the red **X** next to the name of the ELF file, to remove a symbol file from the symbol browser.

F3-2(8) The *expand all* and *collapse all* buttons allow you to browse more efficiently throughout the symbol browser tree.

Be aware that the symbol browser in µC/Probe will detect if the ELF file has been re-compiled and will refresh all addresses. However, in case you move the ELF file to a different location in your file system, µC/Probe cannot update the addresses automatically. Instead, you can update the symbol browser with the new path by first removing the ELF file (red X next to the filename) and then opening the new ELF file.

## 3-2 CDF FILE

The CDF (Chip Definition File) contains the name, data type and address of all your device's I/O registers. µC/Probe installs in your PC with a very large catalog of chip definition files that includes chips from semiconductors such as Analog Devices, Atmel, Cypress, Freescale, Infineon, Renesas, ST, Texas Instruments and Xilinx among others.

## 3-2-1 LOADING A CDF FILE

You can browse the CDF catalog and select your platform's chip definition file by clicking the button *CDF File* and using the CDF browser shown in Figure 3-3:

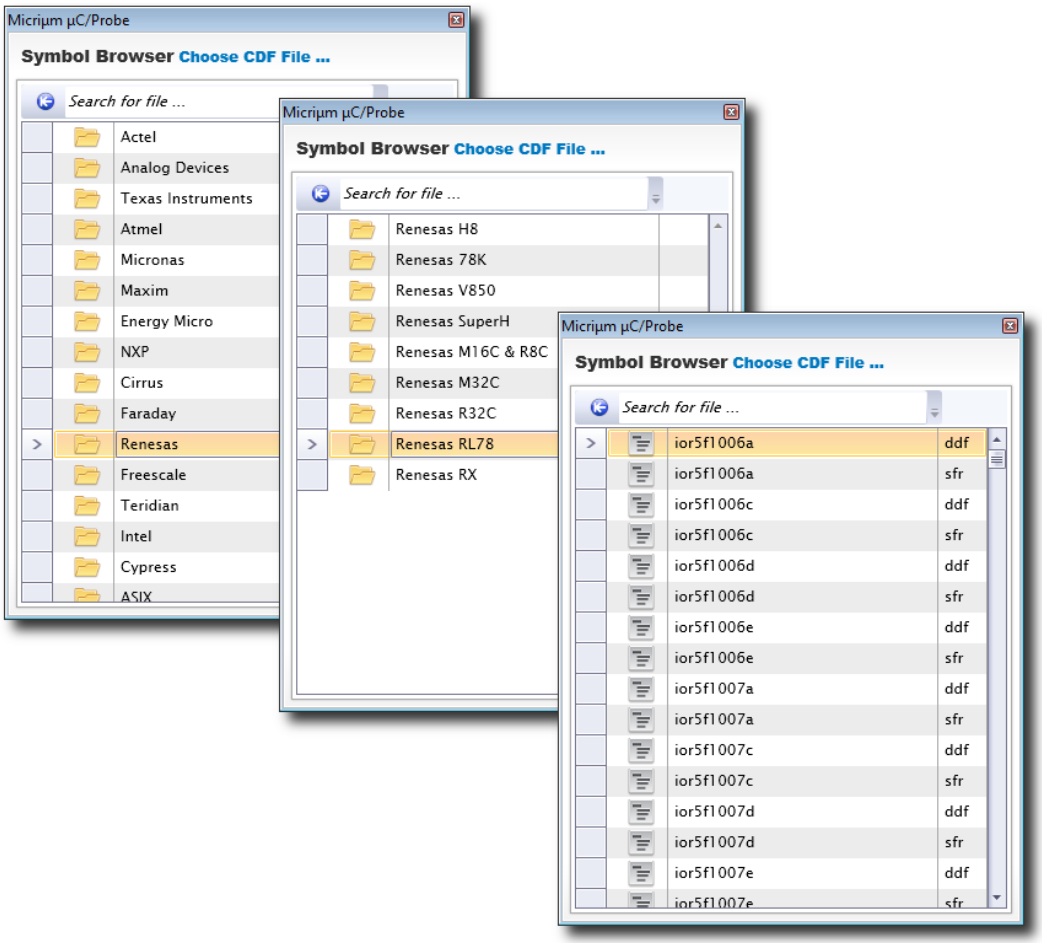



Figure 3-3 **Chip Definition Files Browser**

The CDF files provide the chip's peripheral I/O register names and addresses which you can use to associate with controls such as the *Bit Control* described in section A-2-8 "Bit Control Properties Editor" on page 84.

## 3-3 CSF FILE

µC/Probe is capable of parsing XML-based Custom Symbol Files (CSF), which is very useful for those cases where your toolchain is incapable of generating one of the ELF file formats supported by µC/Probe.

### 3-3-1 CREATING A CSF FILE

The best way to create a CSF file is by modifying the template located in your µC/Probe installation directory at:

```
$\Micrium\uC-Probe\Templates\uC-Probe-CSF-Template.csf
```

The template is associated with an XSD document that defines the XML schema for CSF files supported by µC/Probe. We recommend using an XML editor capable of providing *IntelliSense* features such as Visual Studio, shown in Figure 3-4:

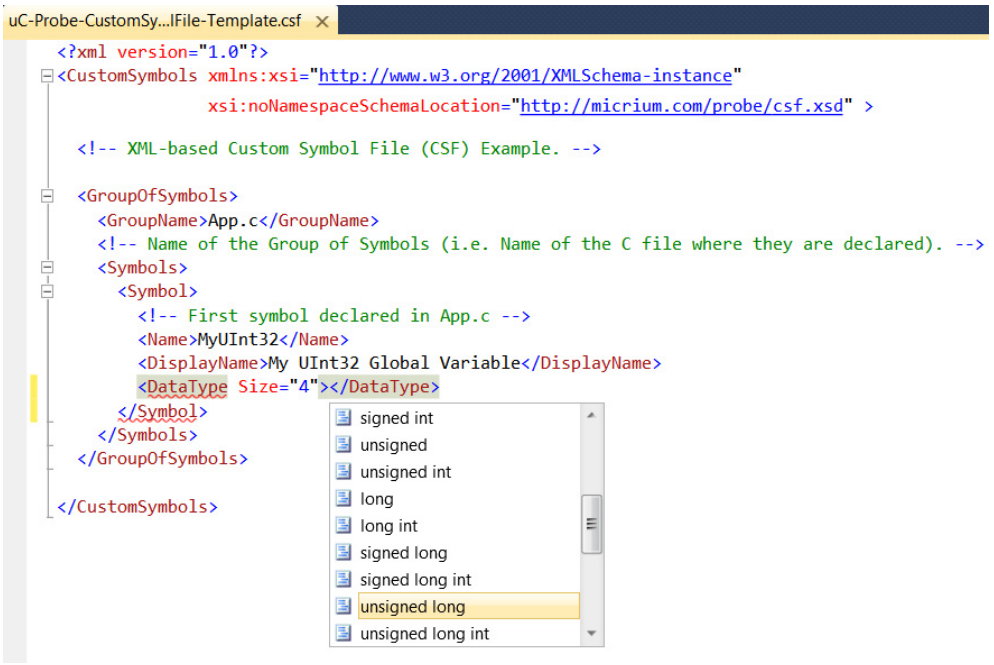



Figure 3-4 **Creating a CSF in Visual Studio: Drop-Down Lists**

Visual Studio makes editing your CSF file easier by filling required XML syntax for you. For example, after a schema is associated with your CSF, you get a drop-down list of expected elements any time you type "<".

When you type *SPACE* from inside a start tag, you also get a drop-down list showing all attributes that can be added to the current element.

Likewise, when you type "=" for an attribute value, or the opening quote for the value, you also get a list of possible values for that attribute.

Moreover, *ToolTips* appear on these IntelliSense lists giving you a description of each element as illustrated in Figure 3-5:

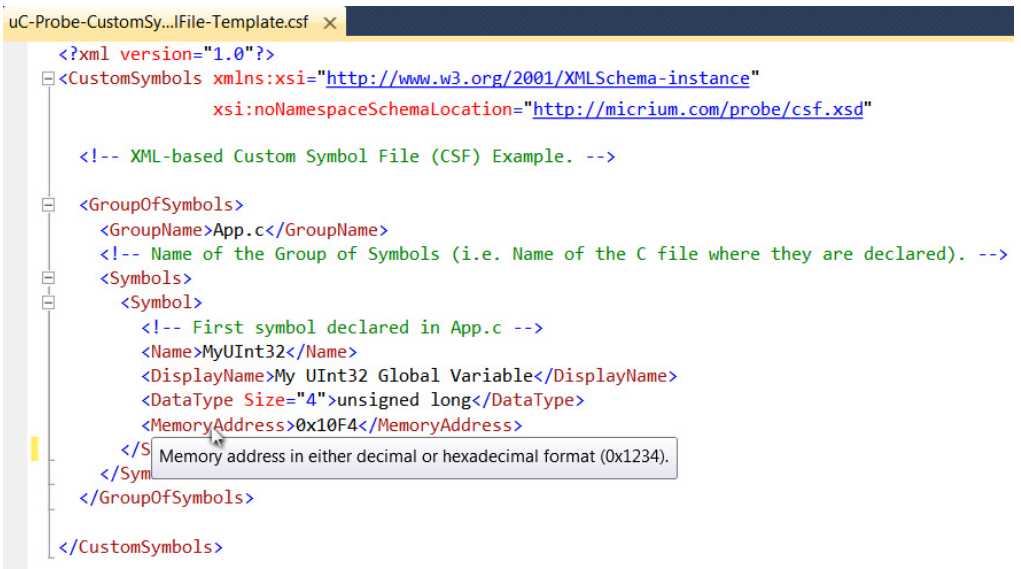



Figure 3-5 **Creating a CSF in Visual Studio: Tool Tips**

Custom Symbol Files need to have the extension `.csf` for µC/Probe to recognize them as such. Listing 3-1 shows an example of a CSF file that declares one integer, one array and one data structure.

```
<?xml version="1.0"?>
<CustomSymbols xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
               xsi:noNamespaceSchemaLocation="http://micrium.com/probe/csf.xsd" >          (1)
  <GroupOfSymbols>                                                                        (2)
    <GroupName>App.c</GroupName>                                                          (3)
    <Symbols>
      <Symbol>
        <Name>MyUInt32</Name>                                                             (4)
        <DisplayName>My UInt32 Global Variable</DisplayName>                              (5)
        <DataType Size="4">unsigned long</DataType>                                       (6)
        <MemoryAddress>0x10F4</MemoryAddress>                                             (7)
      </Symbol>
      <Symbol>
        <Name>MyStruct</Name>
        <DataType Size="50">struct</DataType>
        <MemoryAddress>0x50AC</MemoryAddress>
        <DataMembers>                                                                     (8)
          <Symbol>
            <Name>MyArray</Name>
            <DataType Size="16" IsArray="true" ArrayLength="4">int</DataType>             (9)
            <MemoryAddress>0x50AC</MemoryAddress>
          </Symbol>
          <Symbol>
            <Name>MyCharPointer</Name>
            <DataType Size="4" IsPointer="true">char</DataType>                          (10)
            <MemoryAddress>1025</MemoryAddress>
          </Symbol>
        </DataMembers>
      </Symbol>
    </Symbols>
  </GroupOfSymbols>
</CustomSymbols>
```

Listing 3-1 **XML-based Custom Symbol File Example**

L3-1(1) The root element is called `<CustomSymbols>`. It includes the XSD schema reference to help you editing in an XML editor such as Visual Studio.

L3-1(2) Each symbol or group of symbols are within the element tag `<GroupOfSymbols>`. In this case it is used with the purpose of creating a group of symbols declared in one single C file.

L3-1(3) The name of the group of symbols is `App.c`.

L3-1(4) The name of the first symbol in the group as declared in C.

L3-1(5) You can also specify an alias for the group name for display purposes.

L3-1(6) The element tag `<DataType>` is the ANSI C data type of the variable including the size in bytes as an attribute.

L3-1(7) The element tag `<MemoryAddress>` is the variable's memory address in either decimal or hexadecimal format (0x1234).

L3-1(8) For more complex symbols such as data structures, there is a tag called `<DataMembers>` that allows you to specify a group of symbols that make part of a data structure.

L3-1(9) In order to declare an array, you need to specify three attributes: A boolean flag that indicates that the symbol is an array, the total number of bytes and the number of elements in the array.

L3-1(10) Finally, any data type can be declared as a pointer by using the data type boolean attribute `IsPointer.` In this case, it is the intention to specify a symbol declared as `char *.`

In order to verify your CSF file, you can use the Symbol Browser from within µC/Probe as shown in Figure 3-6. Notice the relationship between the XML tags and the tree nodes in the Symbol Browser.:

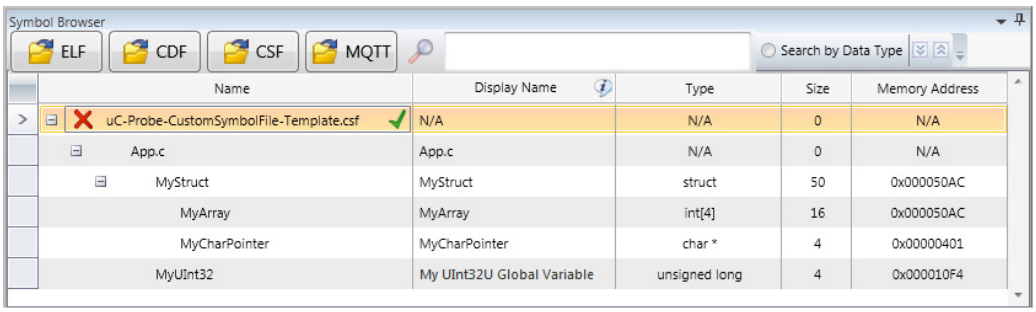



Figure 3-6 **XML-based Custom Symbol File Example as seen from µC/Probe's Symbol Browser**

## 3-4 MQTT CONFIGURATION FILE

The MQTT (Message Queueing Telemetry Transport) protocol is becoming the de facto standard for IoT (Internet of Things) applications.

µC/Probe can be used to build an MQTT Client. If you have an embedded system that is MQTT-ready, you can monitor and control your embedded system remotely by using any of the virtual controls and indicators in µC/Probe's toolbox.

Let's take for example an embedded systems-based *Weather Station* that remotely publishes via MQTT its readings to an MQTT broker as illustrated in Figure 3-7.

The MQTT broker stores the readings and then you can use µC/Probe to create a GUI that displays the readings using some of the virtual indicators (e.g. thermometer to display temperature) and configures the Weather Station with some of the virtual controls (e.g. slider control to configure the sampling rate).

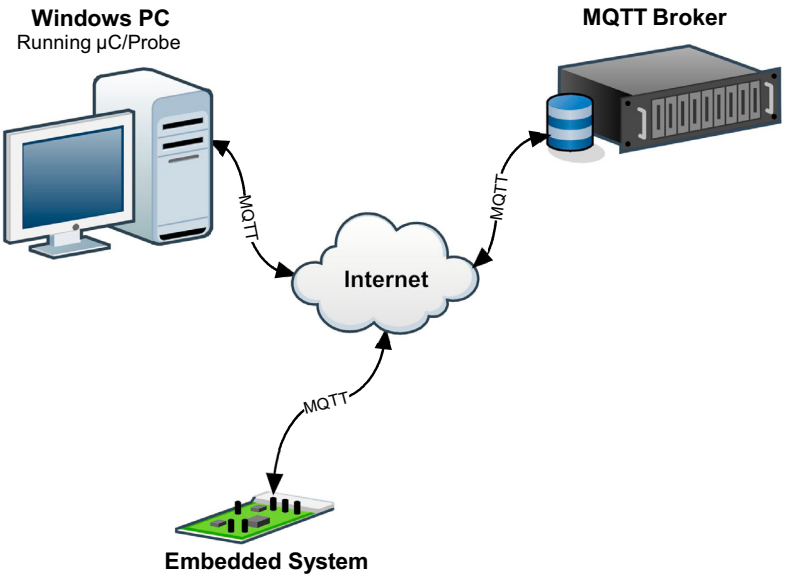



Figure 3-7 **µC/Probe as an MQTT gateway**

The details on how to setup an MQTT broker and how to make an embedded systems MQTT-ready are beyond the scope of this document.

However, a good place to start is looking at 2lemetry as an MQTT broker and Micriμm's μC/TCP-IP and μC/MQTTc as the firmware you need to make your embedded systems MQTT-ready.

The next section will explain how to create an MQTT configuration file assuming that you already have an account and configuration setup at the MQTT broker of your choice.

## 3-4-1 CREATING AN MQTT CONFIGURATION FILE

Similar to the Custom Symbol File (CSF) in section 3-3 "CSF File" on page 19, the best way to create an MQTT configuration file is by modifying the template located in your μC/Probe installation directory at:

```
$\Micrium\uC-Probe\Templates\uC-Probe-MQTT-CfgFile-Template.mqtt
```

The template is associated with an XSD document that defines the XML schema for MQTT configuration files supported by µC/Probe. We recommend using an XML editor capable of providing *IntelliSense* features such as Visual Studio, shown in Figure 3-4:

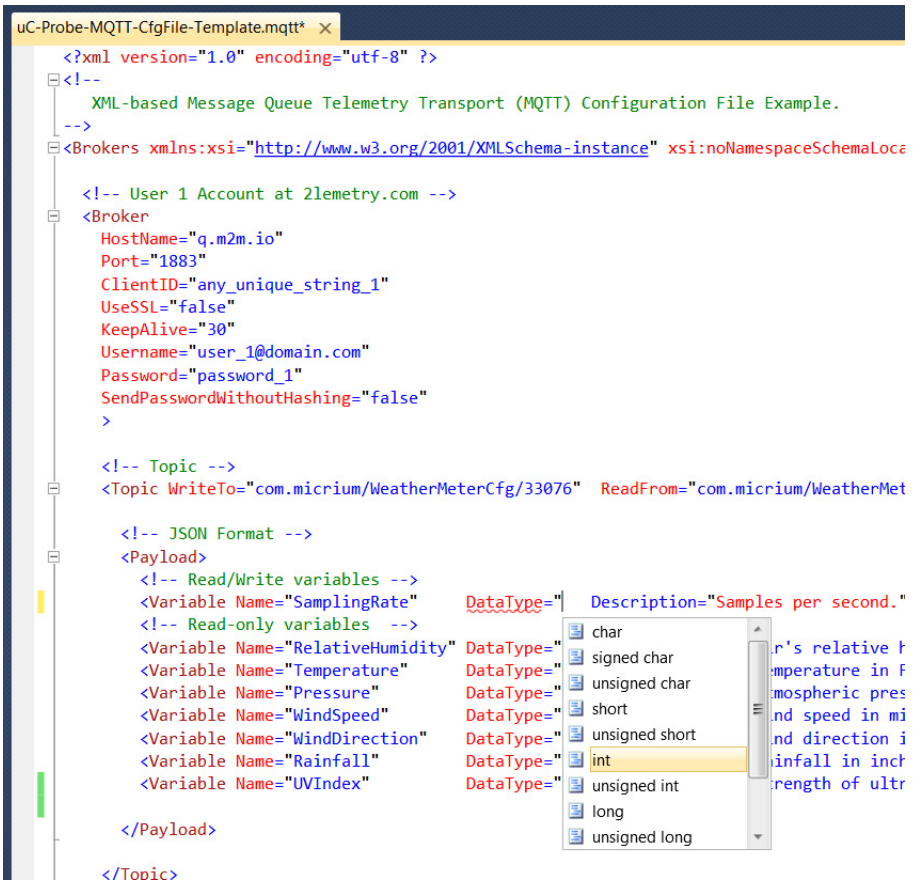



Figure 3-8 **Creating an MQTT Configuration File in Visual Studio: Drop-Down Lists**

Visual Studio makes editing your MQTT configuration file easier by filling required XML syntax for you. For example, after a schema is associated with your MQTT configuration, you get a drop-down list of expected elements any time you type "<".

When you type *SPACE* from inside a start tag, you also get a drop-down list showing all attributes that can be added to the current element.

Likewise, when you type "=" for an attribute value, or the opening quote for the value, you also get a list of possible values for that attribute.

Moreover, *ToolTips* appear on these IntelliSense lists giving you a description of each element as illustrated in Figure 3-5 when the user hovers the mouse over the Topic's **WriteTo** property:

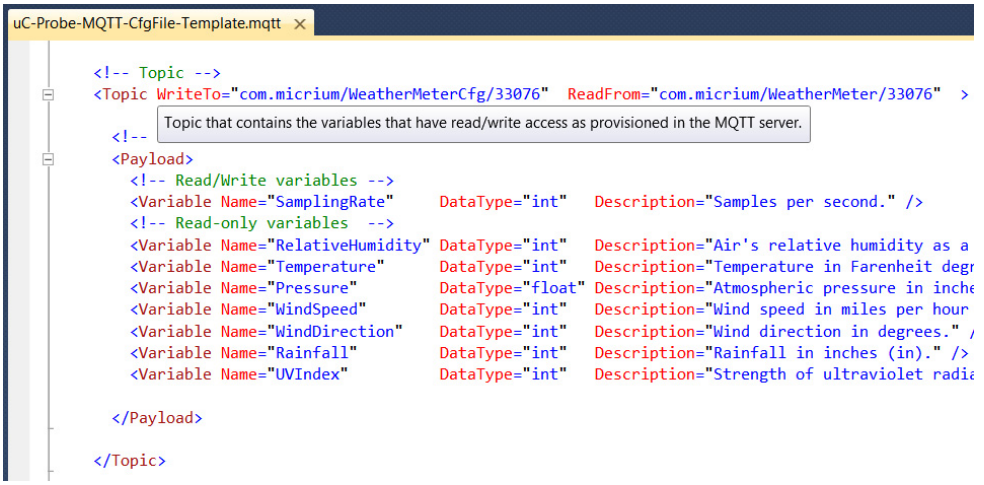



Figure 3-9 **Creating an MQTT Configuration File in Visual Studio: Tool Tips**

MQTT Configuration Files need to have the extension `.mqtt` for µC/Probe to recognize them as such. Listing 3-1 shows an example of an MQTT Configuration File that declares a few variables.

```
<?xml version="1.0" encoding="utf-8" ?>
<!--
   XML-based Message Queue Telemetry Transport (MQTT) Configuration File Example.
-->
<Brokers xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:noNamespaceSchemaLocation="http://micrium.com/probe/mqtt.xsd">                  (1)
  <!-- User 1 Account at 2lemetry.com -->
  <Broker
    HostName="q.m2m.io"
    Port="1883"
    ClientID="any_unique_string_1"
    UseSSL="false"
    KeepAlive="30"
    Username="user_1@domain.com"
    Password="password_1"
    SendPasswordWithoutHashing="false">                                                     (2)
    <!-- Topic -->
    <Topic WriteTo="com.micrium/WeatherMeterCfg/33076"
           ReadFrom="com.micrium/WeatherMeter/33076"  >                                     (3)
      <!-- JSON Format -->
      <Payload>                                                                            (4)
        <!-- Read/Write variables -->
        <Variable Name="SamplingRate"
                  DataType="int"
                  Description="Samples per second." />                                    (5)
        <!-- Read-only variables  -->
        <Variable Name="RelativeHumidity"
                  DataType="int"
                  Description="Air's relative humidity as a percentage (%)." />
        <Variable Name="Temperature"
                  DataType="int"
                  Description="Temperature in Fahrenheit degrees (F)." />
      </Payload>
    </Topic>
  </Broker>
</Brokers>
```

Listing 3-2 **XML-based MQTT Configuration File Example**

L3-2(1) The root element is called `<Brokers>`. Inside this tag, you can have more than one MQTT broker in case your data comes from various sources. The tag includes the XSD schema reference to help you editing in an XML editor such as Visual Studio.

L3-2(2) Each MQTT broker needs to be configured with the access credentials and other settings specific to the account you have with your MQTT broker.

L3-2(3) MQTT brokers are usually provisioned with two topics per device (thing). In this example, the weather meter at zip code 33326 is provisioned with two topics; One that contains the Read/Write access variables and the other one that contains the Read-only access variables. And if you want added security you can even create a separate account for Read/Write access.

L3-2(4) The data to be sent needs to be in JSON format. The tag `<Payload>` specifies the JSON format expected by both the MQTT broker and µC/Probe.

L3-2(5) The tag `<Variable>` allows you to specify the name, data type and an optional description for each variable within a topic.

In order to verify your MQTT configuration file, you can use the Symbol Browser from within µC/Probe as shown in Figure 3-10. Notice the relationship between the XML tags and the tree nodes in the Symbol Browser.:

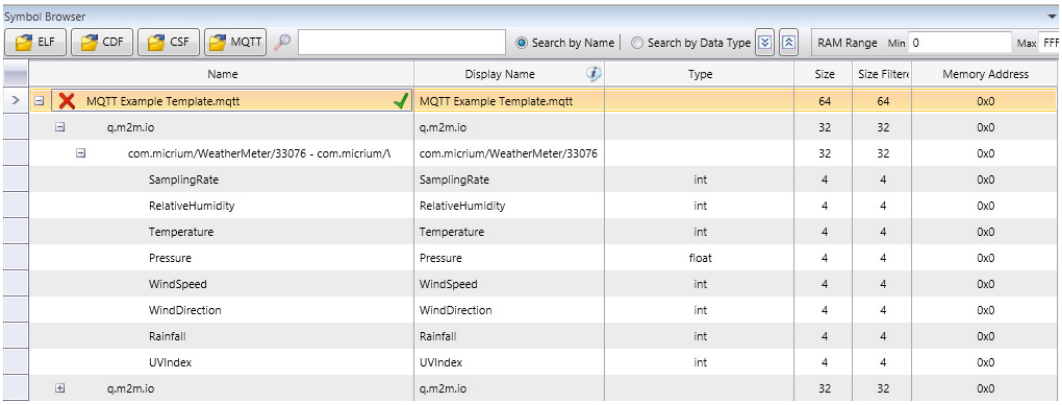



Figure 3-10 **XML-based MQTT Configuration File Example as seen from µC/Probe's Symbol Browser**

## 3-5 DATA FOOTPRINT CALCULATOR

The Data Footprint Calculator sums the space in RAM taken by your embedded target symbols. You simply go to the Symbol Browser and enter the address range as configured in your linker settings and µC/Probe will calculate the totals in the column labeled as **Size Filtered** as illustrated in Figure 3-11. In other words, any symbol that falls into this address range will be used in the calculation.

The reason why the column labeled as **Size** shows footprint amounts larger than those in the column **Size Filtered** is because some of the symbols in your ELF file do not reside in RAM. That is the case with symbols declared as constants which your linker places in ROM (code space).

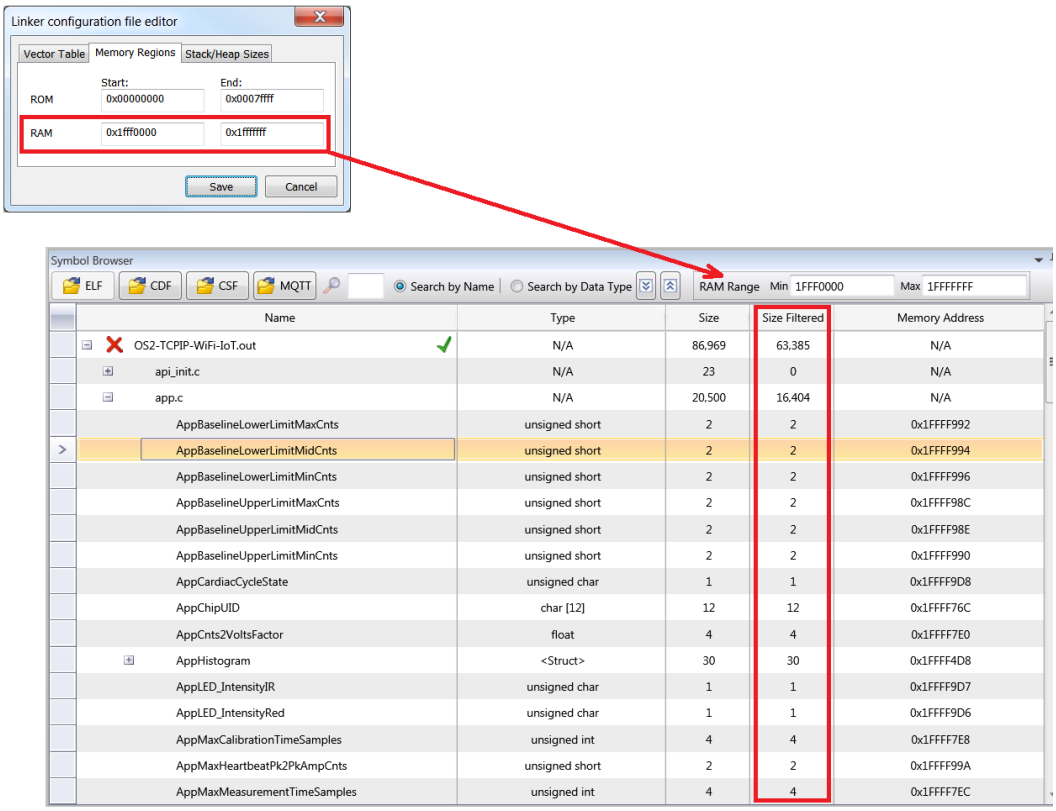



Figure 3-11 **Data Footprint Calculator**

Chapter

# 4

# µC/Probe Settings

The µC/Probe application's tool bar is located at the top of the application window.

The µC/Probe Settings window is opened by making click on the **Settings** button in the application's tool bar as indicated in Figure 4-1:

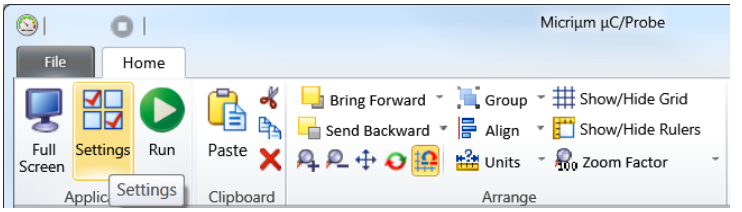



Figure 4-1 **µC/Probe Toolbar: Settings**

The settings window is divided in the following categories:

- General Settings:

  The general settings include the application debug logging, automatic updates and data collection settings.

- Communication Settings:

  The communication settings window includes the endianness type and the communication interface settings.

# 4-1 GENERAL SETTINGS

Figure 4-2 shows the µC/Probe General Settings window:

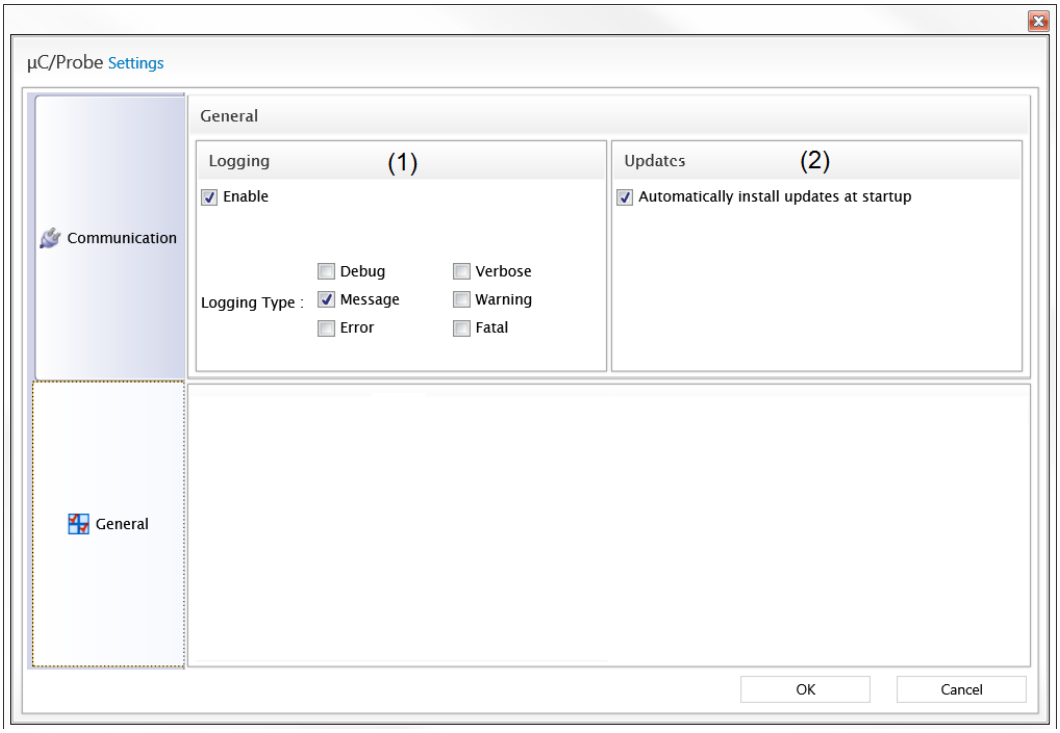



Figure 4-2 **µC/Probe General Settings**

F4-2(1) µC/Probe can be configured to log a specific level of verbosity for technical support purposes. If you ever have to contact Micriµm's technical support for any issues with your µC/Probe application, you can select a logging type that better describes your failure scenario.

F4-2(2) µC/Probe can be configured to automatically check and install updates as they become available from the Micriµm website. µC/Probe will check for software updates at startup if internet access is available.

## 4-2 COMMUNICATION SETTINGS OVERVIEW

µC/Probe supports a variety of communication interfaces that can be classified in four groups:

- Debugger-based Interfaces
- Peripheral-based Interfaces
- 3rd. Party Plugins
- MQTT Interface

The following sections will describe each of the groups.

### 4-2-1 DEBUGGER-BASED INTERFACES

µC/Probe can interface with your embedded target via standard debugging tools such as:

- J-Link
- CMSIS-DAP
- Cypress PSoC Prog
- OpenSDA

When using one of these interfaces, µC/Probe reads and writes your global variables in a non-intrusive way and without the need for any target resident code. These are the ideal interface options if you require to maintain the real-time behavior of your application.

Follow the decisions tree diagram in Figure 4-3 to see if you can use one of these debugger-based interfaces with your platform.

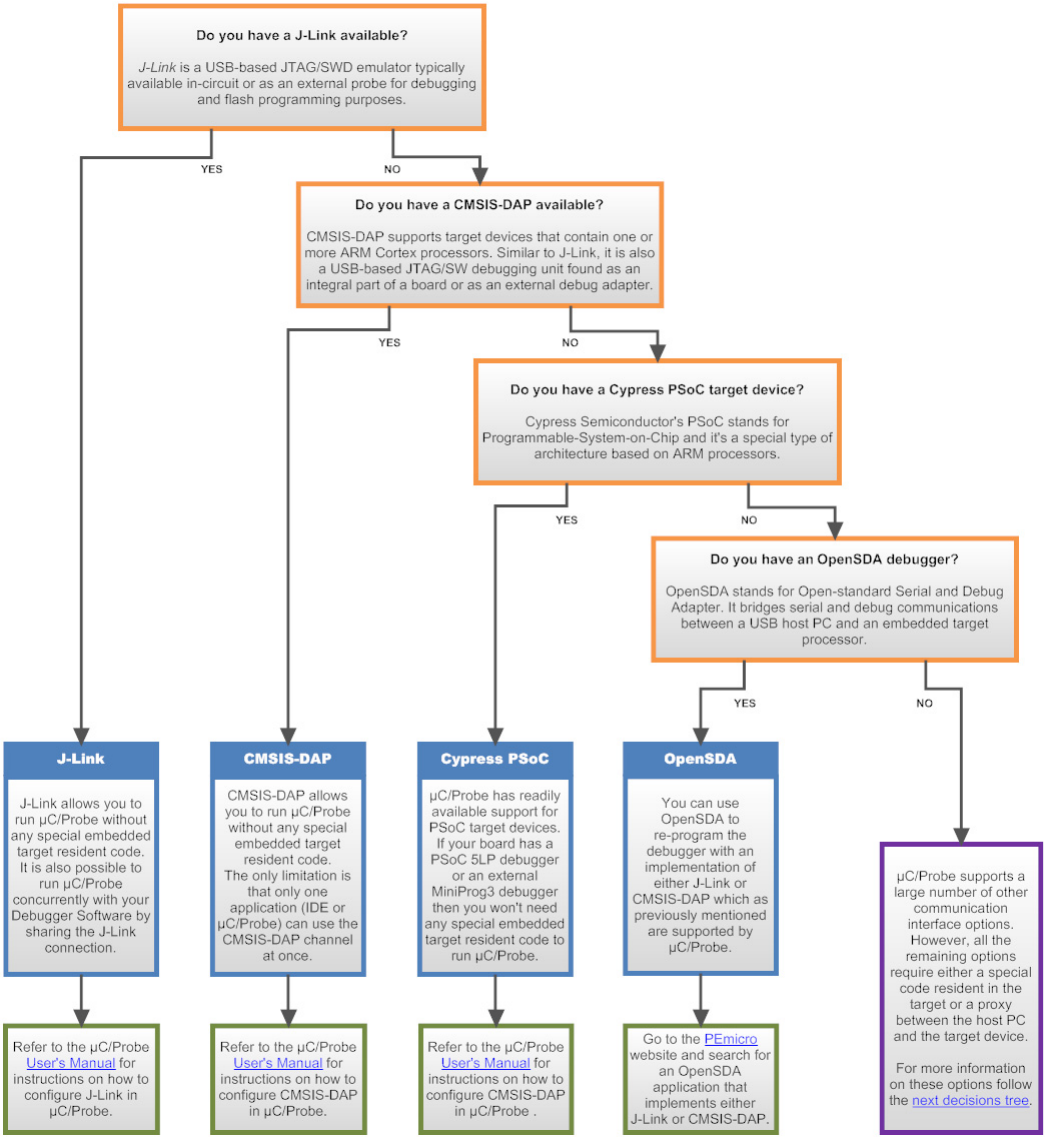

Do you have a J-Link available?
J-Link is a USB-based JTAG/SWD emulator typically available in-circuit or as an external probe for debugging and flash programming purposes.
YES
NO
Do you have a CMSIS-DAP available?
CMSIS-DAP supports target devices that contain one or more ARM Cortex processors. Similar to J-Link, it is also a USB-based JTAG/SW debugging unit found as an integral part of a board or as an external debug adapter.
YES
NO
Do you have a Cypress PSoC target device?
Cypress Semiconductor's PSoC stands for Programmable-System-on-Chip and it's a special type of architecture based on ARM processors.
YES
NO
Do you have an OpenSDA debugger?
OpenSDA stands for Open-standard Serial and Debug Adapter. It bridges serial and debug communications between a USB host PC and an embedded target processor.
YES
NO
J-Link
J-Link allows you to run µC/Probe without any special embedded target resident code. It is also possible to run µC/Probe concurrently with your Debugger Software by sharing the J-Link connection.
Refer to the µC/Probe User's Manual for instructions on how to configure J-Link in µC/Probe.
CMSIS-DAP
CMSIS-DAP allows you to run µC/Probe without any special embedded target resident code. The only limitation is that only one application (IDE or µC/Probe) can use the CMSIS-DAP channel at once.
Refer to the µC/Probe User's Manual for instructions on how to configure CMSIS-DAP in µC/Probe.
Cypress PSoC
µC/Probe has readily available support for PSoC target devices. If your board has a PSoC 5LP debugger or an external MiniProg3 debugger then you won't need any special embedded target resident code to run µC/Probe.
Refer to the µC/Probe User's Manual for instructions on how to configure CMSIS-DAP in µC/Probe .
OpenSDA
You can use OpenSDA to re-program the debugger with an implementation of either J-Link or CMSIS-DAP which as previously mentioned are supported by µC/Probe.
Go to the PEmicro website and search for an OpenSDA application that implements either J-Link or CMSIS-DAP.
µC/Probe supports a large number of other communication interface options. However, all the remaining options require either a special code resident in the target or a proxy between the host PC and the target device.
For more information on these options follow the next decisions tree.

Figure 4-3 **Debugger-based Interfaces**

## 4-2-2 PERIPHERAL-BASED INTERFACES

µC/Probe can interface via the following communication modules:

- USB
- TCP/IP
- RS-232

These interfaces however, require a special target resident code that implements the µC/Probe protocol.

Micriμm has RS-232 drivers for various platforms available for free and if you are a µC/USBD or µC/TCP-IP licensee then µC/Probe is ready to run on these stacks.

Follow the decisions tree diagram in Figure 4-4 to see if you can use one of these interfaces with your platform.

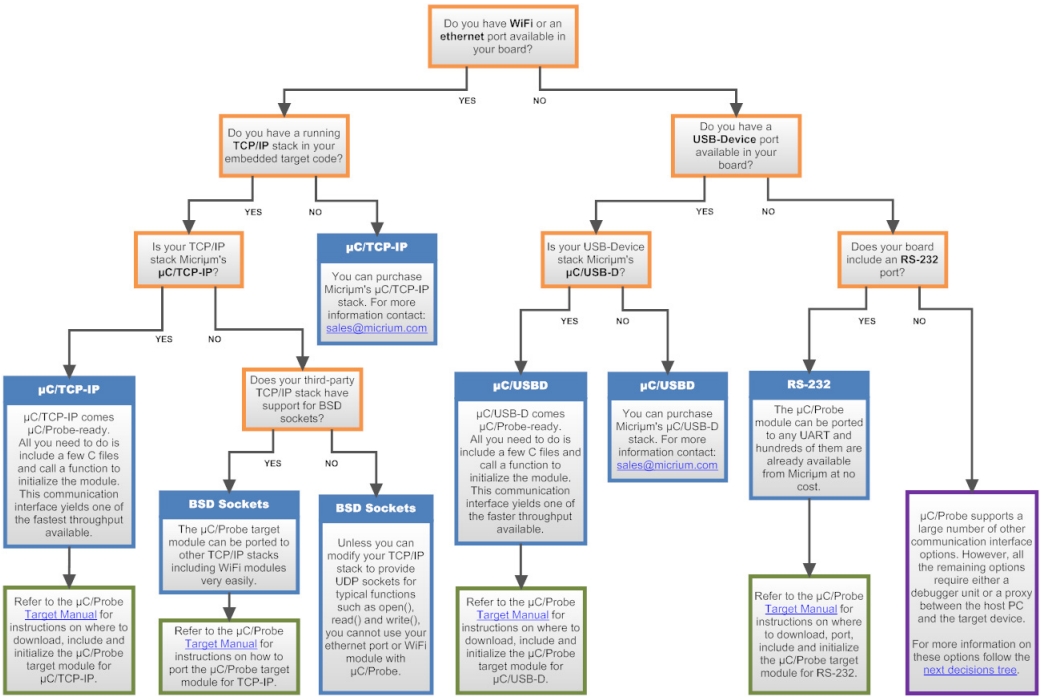

Do you have WiFi or an ethernet port available in your board?
YES
NO
Do you have a running TCP/IP stack in your embedded target code?
YES
NO
Do you have a USB-Device port available in your board?
YES
NO
Is your TCP/IP stack Micrium's µC/TCP-IP?
YES
NO
µC/TCP-IP
You can purchase Micrium's µC/TCP-IP stack. For more information contact: sales@micrium.com
Is your USB-Device stack Micrium's µC/USB-D?
YES
NO
Does your board include an RS-232 port?
YES
NO
µC/TCP-IP
µC/TCP-IP comes µC/Probe-ready. All you need to do is include a few C files and call a function to initialize the module. This communication interface yields one of the fastest throughput available.
Refer to the µC/Probe Target Manual for instructions on where to download, include and initialize the µC/Probe target module for µC/TCP-IP.
Does your third-party TCP/IP stack have support for BSD sockets?
YES
NO
BSD Sockets
The µC/Probe target module can be ported to other TCP/IP stacks including WiFi modules very easily.
Refer to the µC/Probe Target Manual for instructions on how to port the µC/Probe target module for TCP-IP.
BSD Sockets
Unless you can modify your TCP/IP stack to provide UDP sockets for typical functions such as open(), read() and write(), you cannot use your ethernet port or WiFi module with µC/Probe.
µC/USBD
µC/USB-D comes µC/Probe-ready. All you need to do is include a few C files and call a function to initialize the module. This communication interface yields one of the faster throughput available.
Refer to the µC/Probe Target Manual for instructions on where to download, include and initialize the µC/Probe target module for µC/USB-D.
µC/USBD
You can purchase Micrium's µC/USB-D stack. For more information contact: sales@micrium.com
RS-232
The µC/Probe module can be ported to any UART and hundreds of them are already available from Micrium at no cost.
Refer to the µC/Probe Target Manual for instructions on where to download, port, include and initialize the µC/Probe target module for RS-232.
µC/Probe supports a large number of other communication interface options. However, all the remaining options require either a debugger unit or a proxy between the host PC and the target device.
For more information on these options follow the next decisions tree.

Figure 4-4 **Peripheral-based Interfaces**

## 4-2-3 THIRD PARTY PLUGINS

µC/Probe can interface with the embedded target via your IDE thanks to a public API that enables third party software applications to establish a TCP/IP bridge between the IDE and µC/Probe.

The TCP/IP bridge is created in the form of a plugin and gives µC/Probe access to as many platforms as the IDE supports.

Examples of these plugins are:

- IAR Systems C-SPY plugin for µC/Probe
- Eclipse plugin for µC/Probe

Follow the decisions tree diagram in Figure 4-5 to see if you can use one of these plugins with your platform.

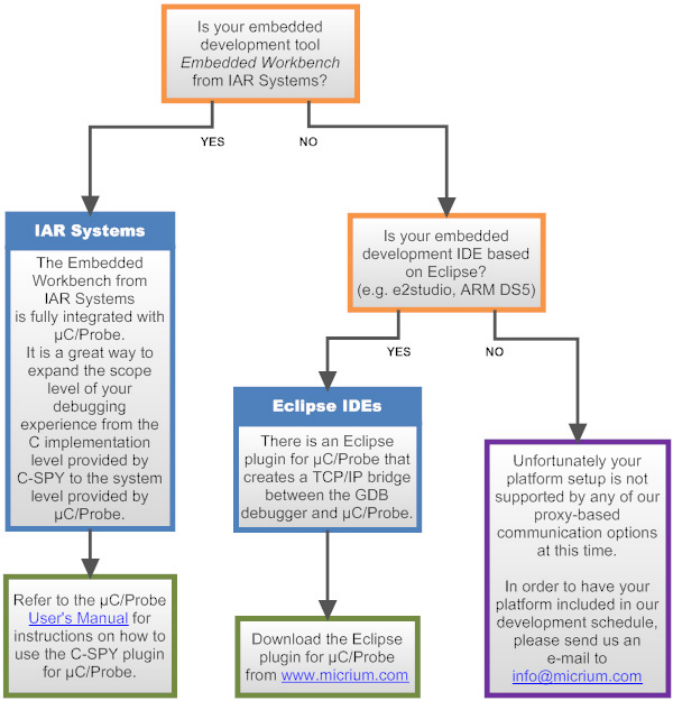

Is your embedded development tool Embedded Workbench from IAR Systems?
YES
NO
IAR Systems
The Embedded Workbench from IAR Systems is fully integrated with µC/Probe. It is a great way to expand the scope level of your debugging experience from the C implementation level provided by C-SPY to the system level provided by µC/Probe.
Refer to the µC/Probe User's Manual for instructions on how to use the C-SPY plugin for µC/Probe.
Is your embedded development IDE based on Eclipse? (e.g. e2studio, ARM DS5)
YES
NO
Eclipse IDEs
There is an Eclipse plugin for µC/Probe that creates a TCP/IP bridge between the GDB debugger and µC/Probe.
Download the Eclipse plugin for µC/Probe from www.micrium.com
Unfortunately your platform setup is not supported by any of our proxy-based communication options at this time.
In order to have your platform included in our development schedule, please send us an e-mail to info@micrium.com

Figure 4-5 **Third Party Plugins**

## 4-2-4 MQTT INTERFACE

µC/Probe can also interface remotely to your embedded target via MQTT.

MQTT is becoming the de facto protocol for IoT applications and µC/Probe can be configured to be an MQTT client for those embedded systems that do not have neither TCP/IP connectivity nor intelligence that implements the MQTT protocol.

## 4-3 COMMUNICATION SETTINGS WINDOW

Once you have chosen the appropriate communication interface for your platform, you can configure µC/Probe from the communication settings window shown in Figure 4-6:

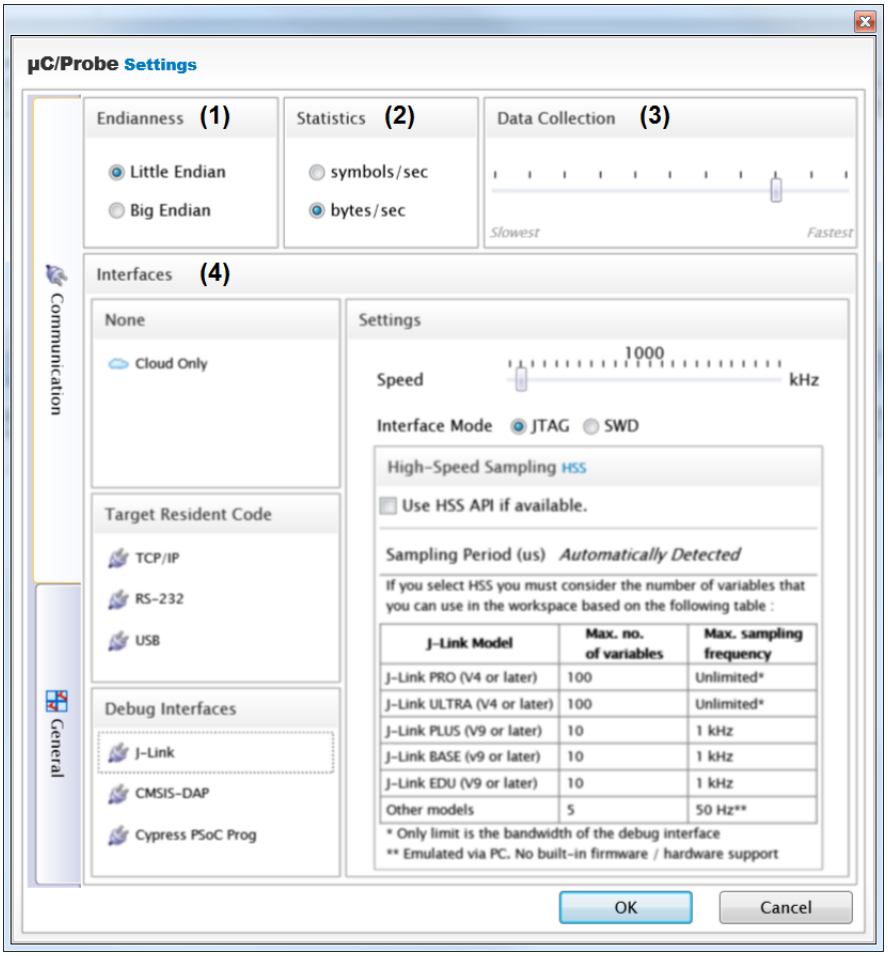



Figure 4-6 **µC/Probe Communication Settings**

F4-6(1) µC/Probe can be configured to interpret the byte order in either little or big endian, select the option that corresponds to your target's endianness type.

F4-6(2) During run-time, µC/Probe calculates the speed of your connection and displays the value in either symbols per second or bytes per second.

F4-6(3) You can adjust how fast you want µC/Probe to make requests to the target depending on your application's bandwidth. The fastest collection rate takes a toll in both the embedded target and your Windows PC resources.

F4-6(4) µC/Probe supports MQTT, J-Link, CMSIS-DAP, Cypress PSoC Prog, USB, TCP/IP and RS-232. Select the interface that your target supports, and configure the settings corresponding to the interface.

The following sections describe how to configure each communication interface. Refer to the document µC/Probe-Target Manual for more information on the communication interface supported by the embedded target.

## 4-3-1 SEGGER J-LINK

J-Link is a USB powered JTAG emulator designed by Segger. In order to install the windows drivers for J-Link (J-Link DLL) go to Segger's website at www.segger.com and download the J-Link software pack for Windows.

J-Link is the most popular emulator for ARM cores and it does not require any special code resident in the embedded target to connect with µC/Probe.

If using J-Link, you can interface µC/Probe even with a bare-metal application running no kernel at all, as shown in Figure 4-7:

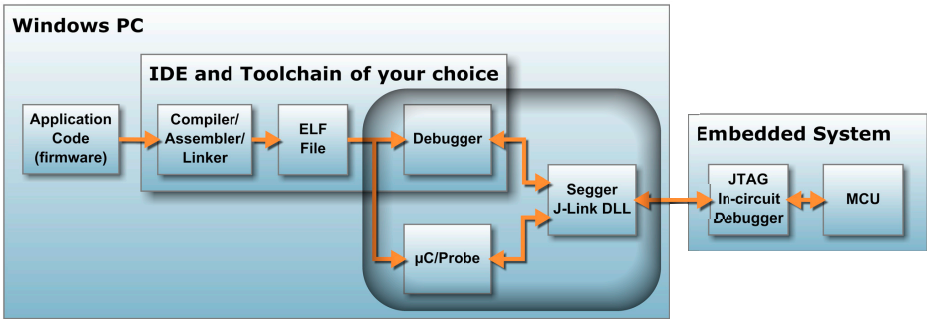



Figure 4-7 **µC/Probe via J-Link**

µC/Probe supports two types of J-link interface modes; JTAG and SWD. Select the interface mode from the radio buttons and configure the J-Link speed from the horizontal slider shown in Figure 4-8. µC/Probe will negotiate the speed you configured and if your device does not support it, then it will select the maximum possible. Additionally, you can select the J-Link High Speed Sampling mode (HSS) which makes it possible to continuously sample variables at extremely high speeds without affecting the real-time nature of the embedded target:

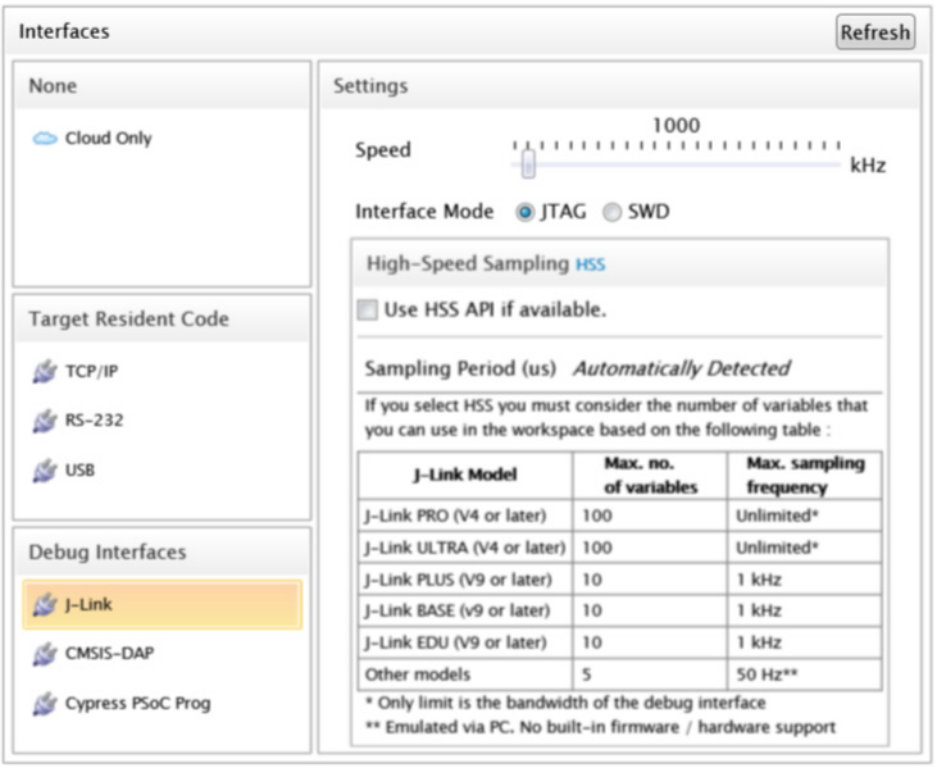

Interfaces
Refresh
None
Cloud Only
Target Resident Code
TCP/IP
RS-232
USB
Debug Interfaces
J-Link
CMSIS-DAP
Cypress PSoC Prog
Settings
Speed
1000
kHz
Interface Mode
JTAG
SWD
High-Speed Sampling HSS
Use HSS API if available.
Sampling Period (us) Automatically Detected
If you select HSS you must consider the number of variables that you can use in the workspace based on the following table :
J-Link Model
Max. no. of variables
Max. sampling frequency
J-Link PRO (V4 or later) 100 Unlimited*
J-Link ULTRA (V4 or later) 100 Unlimited*
J-Link PLUS (V9 or later) 10 1 kHz
J-Link BASE (v9 or later) 10 1 kHz
J-Link EDU (V9 or later) 10 1 kHz
Other models 5 50 Hz**
* Only limit is the bandwidth of the debug interface
** Emulated via PC. No built-in firmware / hardware support

Figure 4-8 **µC/Probe Communication Settings: J-Link**

## 4-3-2 CMSIS-DAP

CMSIS-DAP is the interface firmware for an ARM Cortex processor's Debug Unit that connects the Debug Port to USB. µC/Probe which executes on a host computer, connects via USB to the Debug Unit and to the device that runs the application software. The Debug Unit connects via JTAG or SW to the target device.

The CMSIS-DAP interface does not require you to install any drivers, simply connect a USB cable between your board debug port and your Windows PC and then select the CMSIS-DAP interface from the Settings window as shown in Figure 4-9:

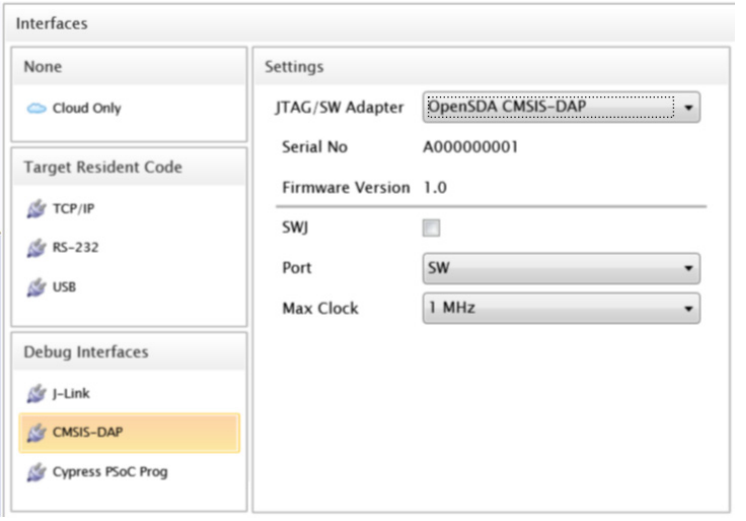



Figure 4-9 **µC/Probe Communication Settings: CMSIS-DAP**

Keep in mind that the CMSIS-DAP interface supports the communication of one single client at a time. In other words, you cannot run µC/Probe and your debugger software at the same time.

## 4-3-3 CYPRESS PSOC PROG

Cypress have their own debugging interface for their PSoC devices called PSoC Programmer. The interface allows you to not only program and configure the PSoC device but also to debug it. µC/Probe is tightly integrated with Cypress PSoC 5LP devices through this interface.

To use this interface with your Cypress PSoC 5LP device you need to download and install PSoC Programmer from the Cypress website at: `http://www.cypress.com`

Then you simply connect the board and select the PSoC Prog interface from the Settings menu as shown in Figure 4-10:

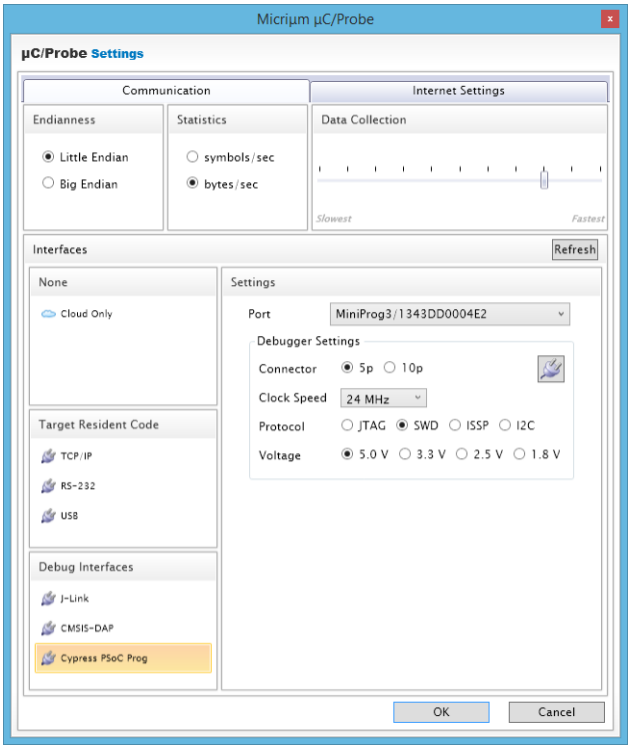



Figure 4-10 **µC/Probe Communication Settings: Cypress PSoC Prog**

Keep in mind that the Cypress PSoC Prog interface supports the communication of one single client at a time. In other words, you cannot run µC/Probe and your debugger software at the same time.

## 4-3-4 USB

µC/Probe supports a USB interface over the µC/USB Device stack by Micriµm. This USB interface requires µC/Probe-Target code resident in your embedded system and because of the nature of USB, it also requires a kernel. Micriµm supports many cores and most likely this code is available from Micriµm. Contact Micriµm to find out if resident code for your particular setup is available.

Once your embedded system is running µC/Probe-Target as described in the document µC/Probe-Target Manual, the device should be ready to connect after plugging in. The Windows computer will enumerate the device and will display it as one of the available devices in the communication settings window as shown in Figure 4-11:

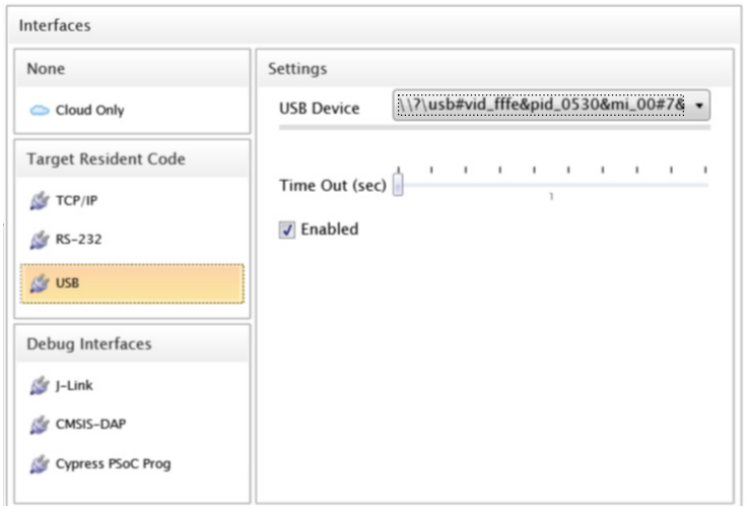



Figure 4-11 **µC/Probe Communication Settings: USB**

You can specify an optional timeout in seconds, which is the time µC/Probe is willing to wait for the target to respond before presenting an error message.

## 4-3-5 TCP/IP

µC/Probe supports a TCP/IP interface over the UDP protocol. The target requires a TCP/IP stack that provides a BSD sockets interface. Regardless of the TCP/IP stack being used, this interface requires µC/Probe-Target code resident in your embedded system and because of the nature of TCP/IP, it also requires a kernel. Micriμm supports many cores and most likely this code is available from Micriμm. Contact Micriμm to find out if resident code for your particular setup is available.

Assuming your embedded system is running µC/Probe-Target as described in the document µC/Probe-Target Manual, enter the IP address and port number of your embedded system in the text boxes shown in Figure 4-12:

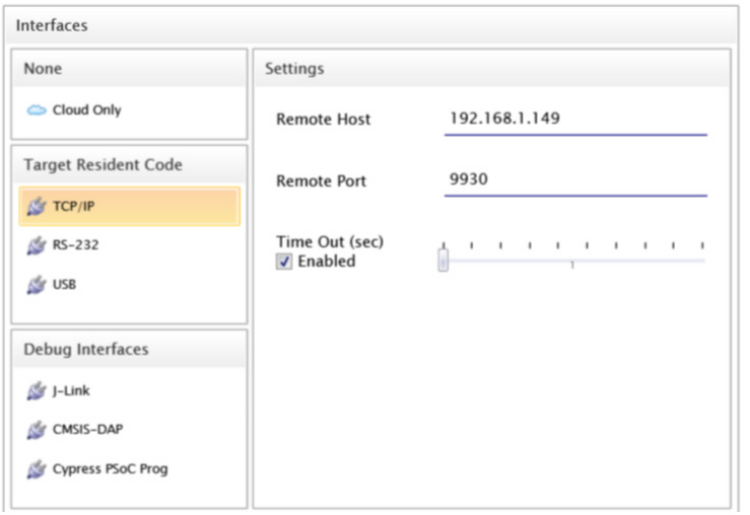



Figure 4-12 **µC/Probe Communication Settings: TCP/IP**

You can specify an optional timeout in seconds, which is the time µC/Probe is willing to wait for the target to respond before presenting an error message.

The TCP/IP interface is also used to interface through third-party plugin proxies such as the IAR Systems C-SPY plugin for µC/Probe as described in section 9-3 “IAR Systems C-SPY Plugin for µC/Probe” on page 65.

### 4-3-6 RS-232

µC/Probe supports a Serial RS-232 interface. This serial interface requires µC/Probe-Target code resident in your embedded system. Micriμm supports many UARTs and most likely this code is available from Micriμm. Contact Micriμm to find out if resident code for your particular setup is available.

Assuming your embedded system is running µC/Probe-Target as described in the document µC/Probe-Target Manual, enter the serial COM port number that your embedded target is attached to and select the baud rate from the drop downs shown in Figure 4-13:

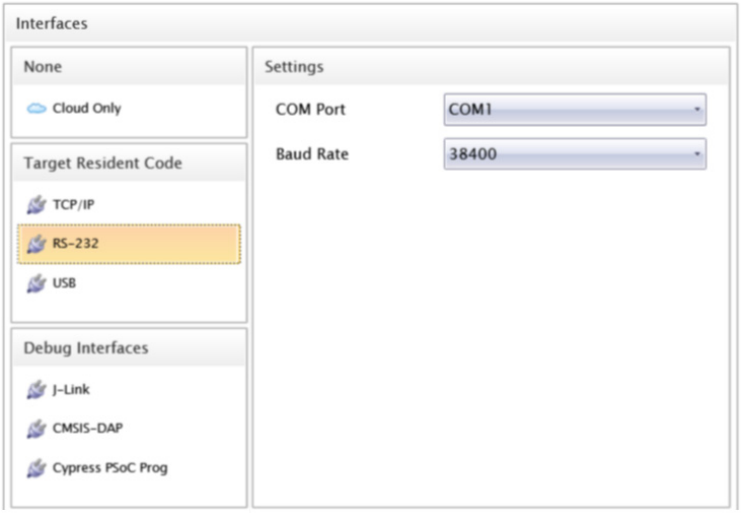



Figure 4-13 **µC/Probe Communication Settings: RS-232**

Chapter

# 5

# µC/Probe Workspace Explorer

The µC/Probe Workspace Explorer is located on the right side of the application window and it is shown in Figure 5-1:

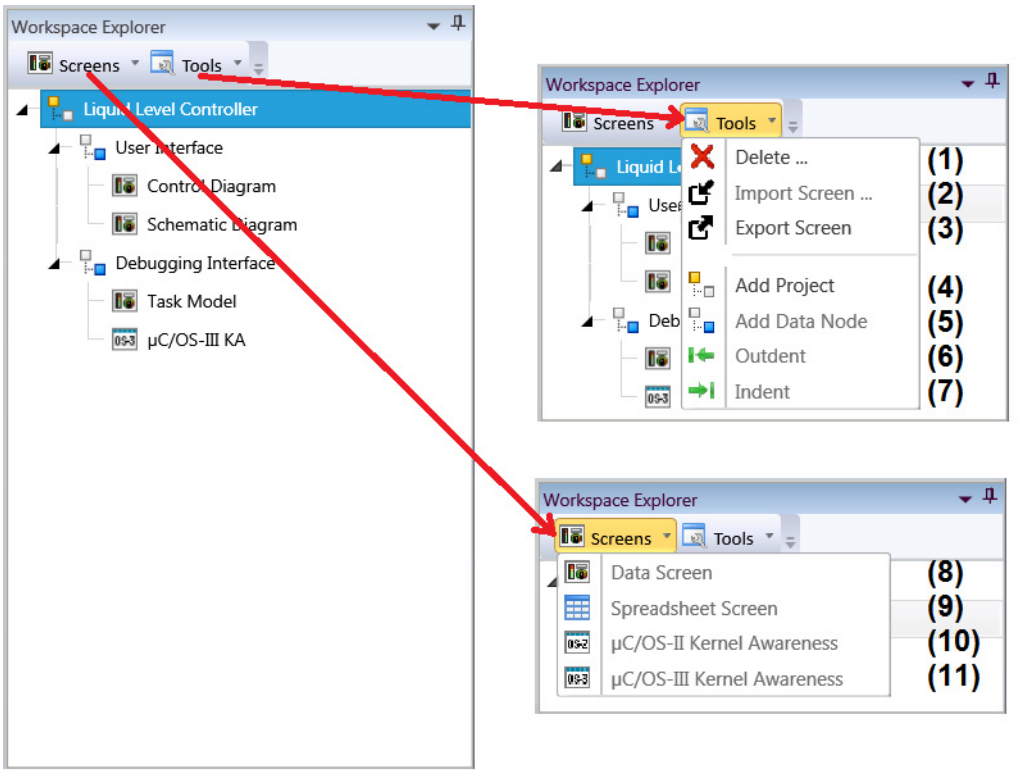



Figure 5-1 **µC/Probe Workspace Explorer**

F5-1(1) Use the Delete button to delete an item from the workspace explorer, including Projects, Data Nodes, Data Screens and Kernel Awareness Screens.

F5-1(2) Use the Import Screen button to import a previously exported screen.

F5-1(3) Use the Export Screen button to export the screen currently in focus to a file.

F5-1(4) µC/Probe allows you to create a dashboard or user interface in a matter of minutes. The data screen is where you drag and drop the virtual controls and indicators. Your data screen's appearance and layout are very important. You can use Projects as a means to separate complex dashboards into multiple regions. Each project can contain multiple data screens and the workspace explorer allows you to navigate through this hierarchy.

F5-1(5) Similar to Projects, Data Nodes are just another level of hierarchy that allows you to group sets of virtual controls and indicators together into categories you define.

F5-1(6) Use the outdent button to push out an item in the Workspace Explorer tree. The items you can outdent include Projects, Data Nodes, Data Screens and Kernel Awareness Screens.

F5-1(7) Use the indent button to push in an item in the Workspace Explorer tree. The items you can adjust the level of indentation include Projects, Data Nodes, Data Screens and Kernel Awareness Screens.

F5-1(8) Data Screens are the screens where you drag and drop the virtual controls and indicators. You can add as many data screens as you want.

F5-1(9) Use this button to create a bridge between µC/Probe and Microsoft Excel.

F5-1(10) The Kernel Awareness Screen is a pre-configured Data Screen with all the symbols related to µC/OS-III. See Appendix B, "Micriµm Software Awareness Screens" on page 101 for more information about this.

F5-1(11) The Kernel Awareness Screen is a pre-configured Data Screen with all the symbols related to µC/OS-II. See Appendix B, "Micriµm Software Awareness Screens" on page 101 for more information about this.

In order to organize your workspace tree you can also use your mouse to drag and drop items and rename items by invoking the context menu with a right-click.

Figure 5-2 shows an example of using projects and data nodes to better present a control panel for a liquid level control system:

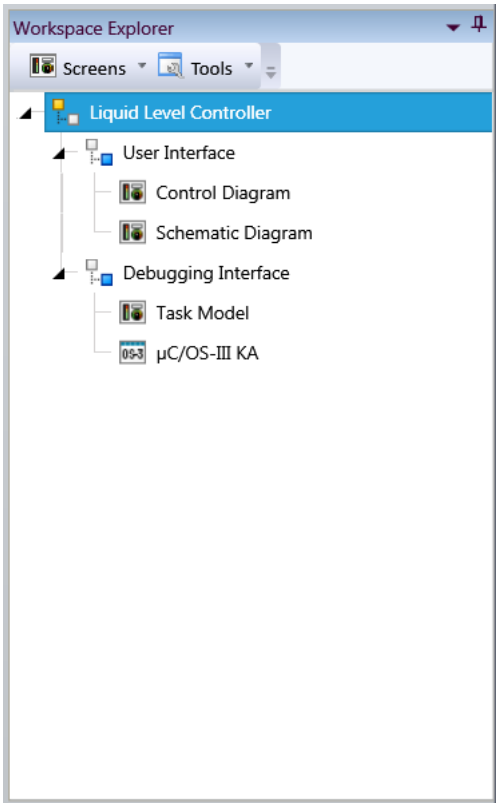



Figure 5-2 **Workspace Explorer for a Liquid Level Control System**

Chapter

# 6

# µC/Probe Toolbox

The µC/Probe Toolbox is located on the left side of the application window and it is shown in Figure 6-1:

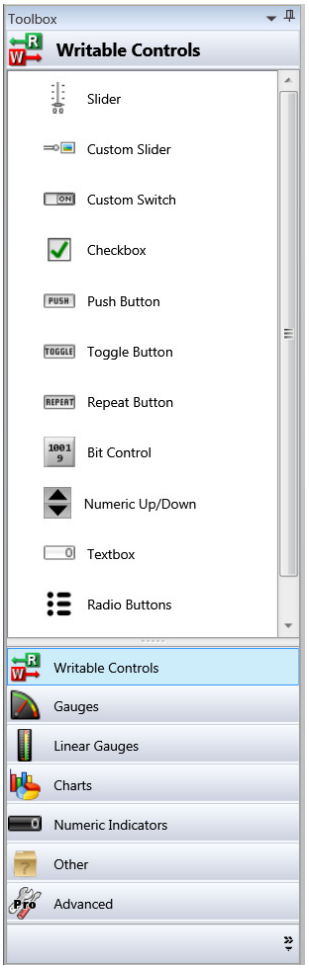



Figure 6-1 **µC/Probe Toolbox**

Depending on the µC/Probe Edition you purchased, the available tools will vary. This document describes all the features found in the Professional Edition of µC/Probe. For more information on which features you have, see Appendix I, "µC/Probe Editions Comparison Table" on page 148.

The items in the toolbox are contained in an accordion type of panel. You click on each button to display the items that belong to a category.

If you are running the Basic or Professional Edition of µC/Probe and have the automatic updates enabled, each category in this toolbox will expand with more virtual controls and indicators as software updates become available.

The following sections present a brief introduction to each of the toolbox categories. For more information on configuring each type of virtual control or indicator, see Appendix A, "Configuring Virtual Controls and Indicators" on page 68.

## 6-1 WRITABLE CONTROLS

The writable controls shown in Figure 6-2 include buttons, check boxes, sliders, radio buttons, a bit control, an RGB LED color picker, a numeric up/down and a textbox. Use these controls to read and modify the value of symbols from the embedded target. For more information configuring the properties of writable controls see Appendix A, "Virtual Controls" on page 76.

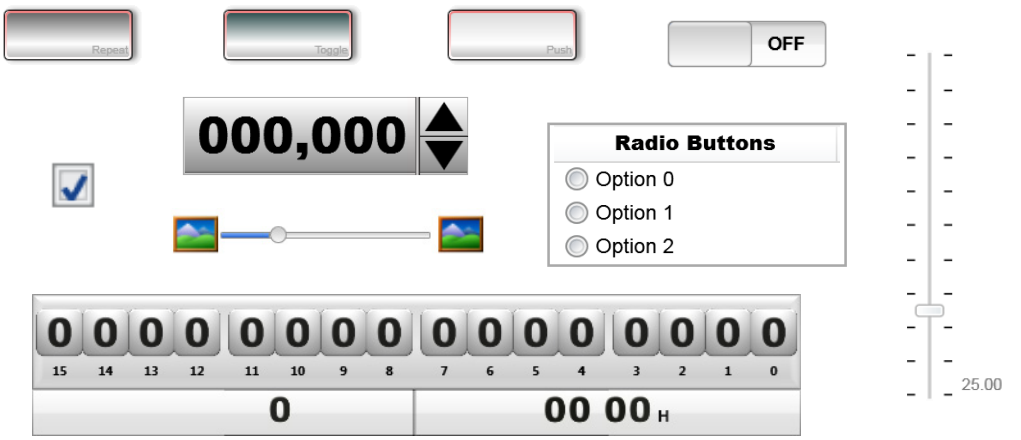



Figure 6-2 **µC/Probe Toolbox: Writable Controls**

## 6-2 LINEAR GAUGES

Use the linear gauges shown in Figure 6-3 to display numeric data in a tri-color linear scale, in terms of percentage or degrees of temperature. For more information configuring the properties of linear gauges see Appendix A, “Virtual Indicators” on page 69.

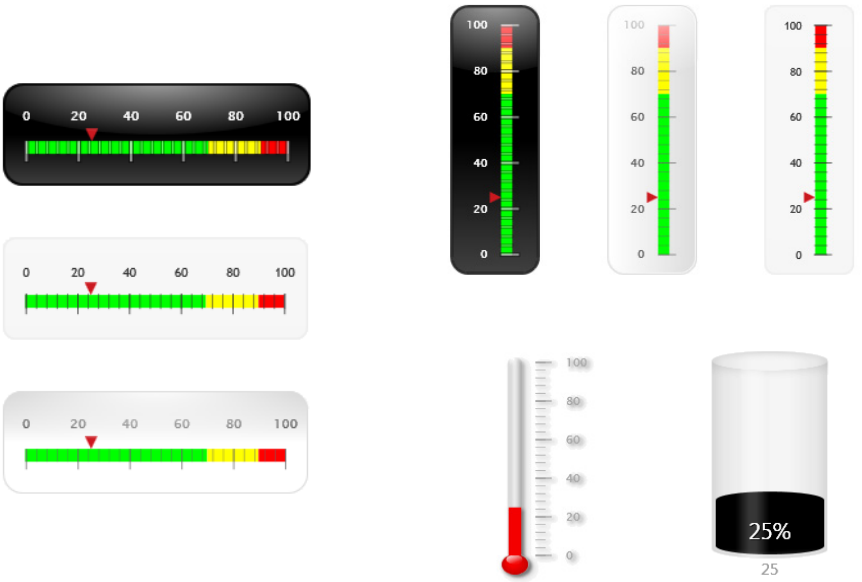



Figure 6-3 **µC/Probe Toolbox: Linear Gauges**

## 6-3 ANGULAR GAUGES

Use the angular gauges shown in Figure 6-4 to display numeric data in a tri-color angular scale. For more information configuring the properties of angular gauges see Appendix A, “Virtual Indicators” on page 69.

Figure 6-4 **µC/Probe Toolbox: Angular Gauges**

## 6-4 CHARTS

Use the charts shown in Figure 6-5 to display numeric data including arrays in a marker, line, area or scatter x-y chart. For more information configuring the properties of charts see Appendix A, “Timeline Charts” on page 92.

Figure 6-5 **µC/Probe Toolbox: Charts**

## 6-5 NUMERIC INDICATORS

Use the numeric indicators shown in Figure 6-6 to display numeric data in text. For more information configuring the properties of numeric indicators see Appendix A, “Formatting Properties Editor” on page 69 and Appendix A, “Numeric Indicator Properties Editor” on page 71.

Figure 6-6 **µC/Probe Toolbox: Numeric Indicators**

## 6-6 ADVANCED

The advanced category of the toolbox includes other miscellaneous indicators such as a text box, terminal window, scripting control, spreadsheet control, µC/Trace trigger control, data logger, HID control and an image container capable of displaying an indexed array of images. For more information configuring the properties of these advanced controls see Appendix A, “Virtual Indicators” on page 69, Appendix E, “Spreadsheet Control” on page 120 and Appendix F, “Scripting Control” on page 130.

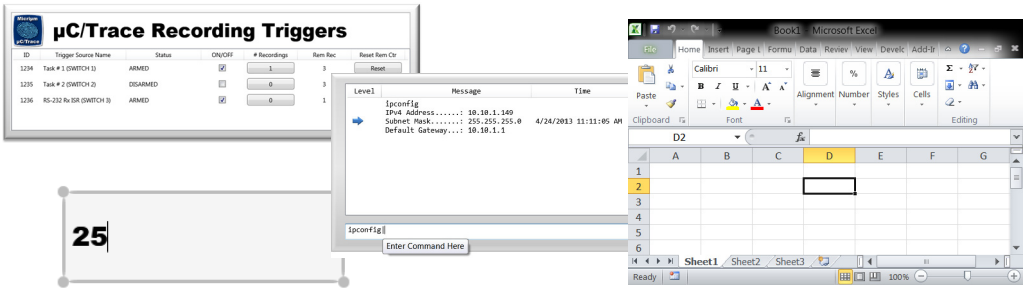



Figure 6-7 **µC/Probe Toolbox: Advanced**

## 6-7 MISCELLANEOUS

All the rest of virtual indicators and controls are located in the *Miscellaneous* category. The image below shows some of them.

Use the LEDs shown in Figure 6-8 to display not only boolean data types but also any numeric variable that represents a color code in ARGB format. For more information configuring the properties of LEDs see Appendix A, “Formatting Properties Editor” on page 69 and Appendix A, “LED Properties Editor” on page 72.

Use the Compass indicator to display azimuth data in degrees; where 0 represents North and it increments clockwise up to 359.

Figure 6-8 **µC/Probe Toolbox: Miscellaneous**

Chapter

# 7

# µC/Probe Layout Design Tools

The Layout Design Tools are located on the Main Toolbar at the top of the application's window. They include tools to arrange the virtual controls and indicators on your data screen as shown in Figure 7-1:

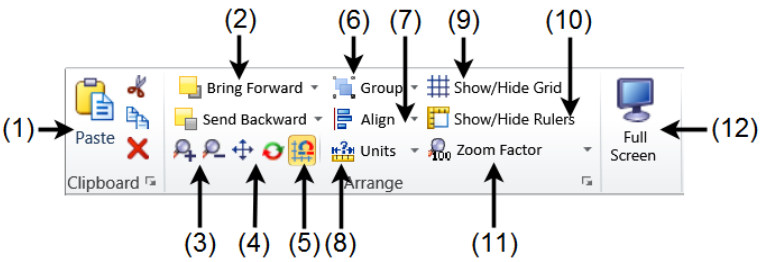



Figure 7-1 **µC/Probe Layout Design Tools**

F7-1(1) µC/Probe allows you to copy, cut and paste a single or multiple virtual controls or indicators. Everything you select will be stored temporarily into µC/Probe's clipboard during your session.

F7-1(2) µC/Probe allows you to drag and drop virtual controls and indicators onto the data screen and have them overlap one another. In some cases may be necessary to move some of them to the front of the data screen. Select the virtual control and indicator you want to move and click the **Bring Forward** or **Send Backward** button to move it to the front or to the back respectively.

F7-1(3) µC/Probe includes accessibility features that make the software more user friendly. You can control the zoom level of your µC/Probe Data Screen during both design-time and run-time. Click the buttons with the magnifier glass to zoom in and out, or use the keyboard shortcuts **Ctrl+** to zoom-in and **Ctrl-** to zoom-out.

F7-1(4) The panning tool in µC/Probe makes it easy to move a data screen around while your are zoomed in. The **Pan** button is a toggle button, clicking the button toggles the panning mode on and off.

F7-1(5) When you drag and drop a virtual control or indicator onto the data screen, the next thing you usually do is resize or move the object around the data screen. Turn the Snap-to-Grid mode on in order to align the virtual control or indicator to the nearest intersection of grid lines. The **Snap to Grid** button is a toggle button, clicking the button toggles the snap-to-grid mode on and off.

F7-1(6) You can combine multiple virtual controls and indicators so you can work with them as though they were a single object. You can resize, move, copy and paste all virtual controls and indicators in a group as a single unit.

After you have grouped virtual controls and indicators, you can still select any single object within the group without un grouping by first selecting the group, and then clicking on the object you want to select.

F7-1(7) µC/Probe allows you to easily align virtual controls and indicators by first selecting the group of objects you want to align and then clicking on one of the following alignment options:

- Left or Right Edges
- Top or Bottom Edges
- Horizontal or Vertical Centers

All the objects are aligned with respect to the first selected item.

F7-1(8) Use the **Units** button to select the grid and ruler's metric system.

F7-1(9) Use the **Show/Hide Grid** button to show and hide the grid lines on the data screen. The snap-to-grid mode still works even if the grid is not visible.

F7-1(10) Use the **Show/Hide Rulers** button to show or hide the ruler. The Show/Hide Rulers button is a toggle button, clicking the button turns the rulers on and off.

F7-1(11) Every time you click the magnifier glass buttons to zoom in and out, µC/Probe zooms in and out by certain zooming factor. Click the **Zoom Factor** button to select a different zooming factor.

F7-1(12) Click the **Full Screen** mode button to hide all the tools except the data screen. The Full Screen button is a toggle button, clicking the button turns the full screen mode on and off.

## 7-1 µC/PROBE EXAMPLE

In order to demonstrate the previous layout design tools, Figure 7-2 shows an example of a power plant's diagram used as a background to create a control panel with µC/Probe:

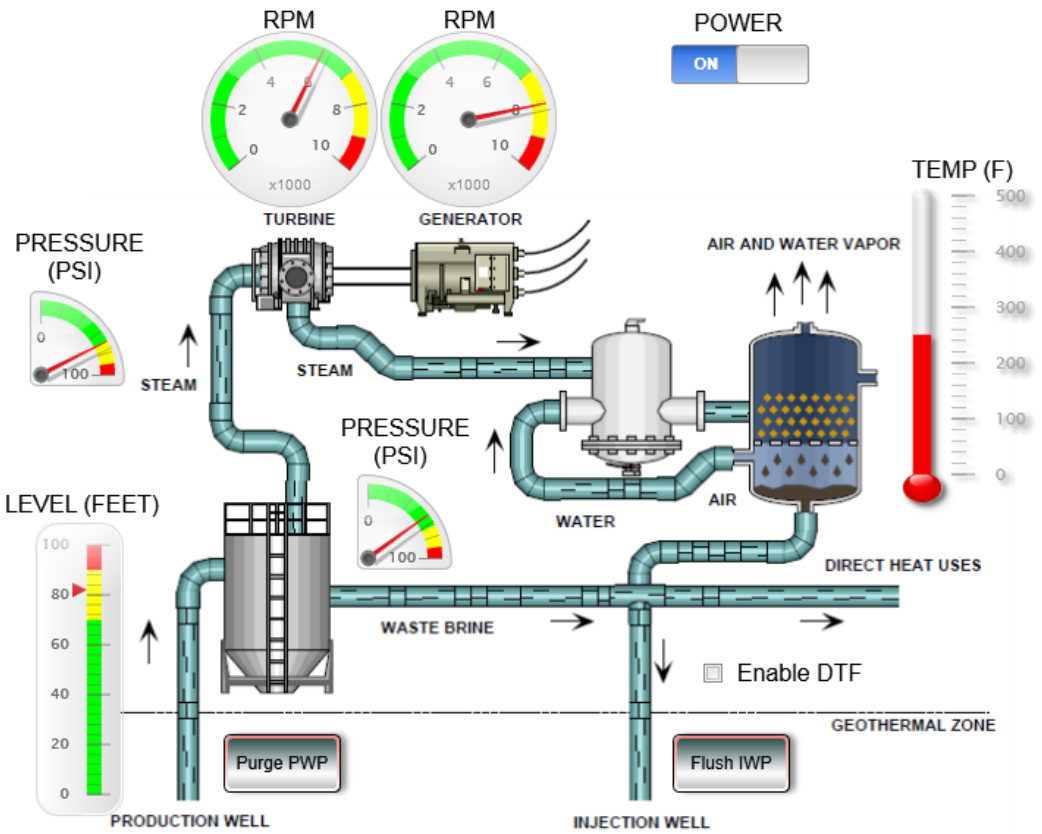



Figure 7-2 **µC/Probe Example of a Power Plant**

Chapter

# 8

# Associating Symbols to Virtual Controls and Indicators

During design-time, use the µC/Probe symbol browser discussed in Chapter 3, “µC/Probe Symbol Browser” on page 15, to search and select the embedded target variables you want to associate to each of the virtual controls and indicators you placed on your data screen.

Once you find the symbol you want to associate, drag and drop the symbol over the virtual control or indicator you want, as shown in Figure 8-1:

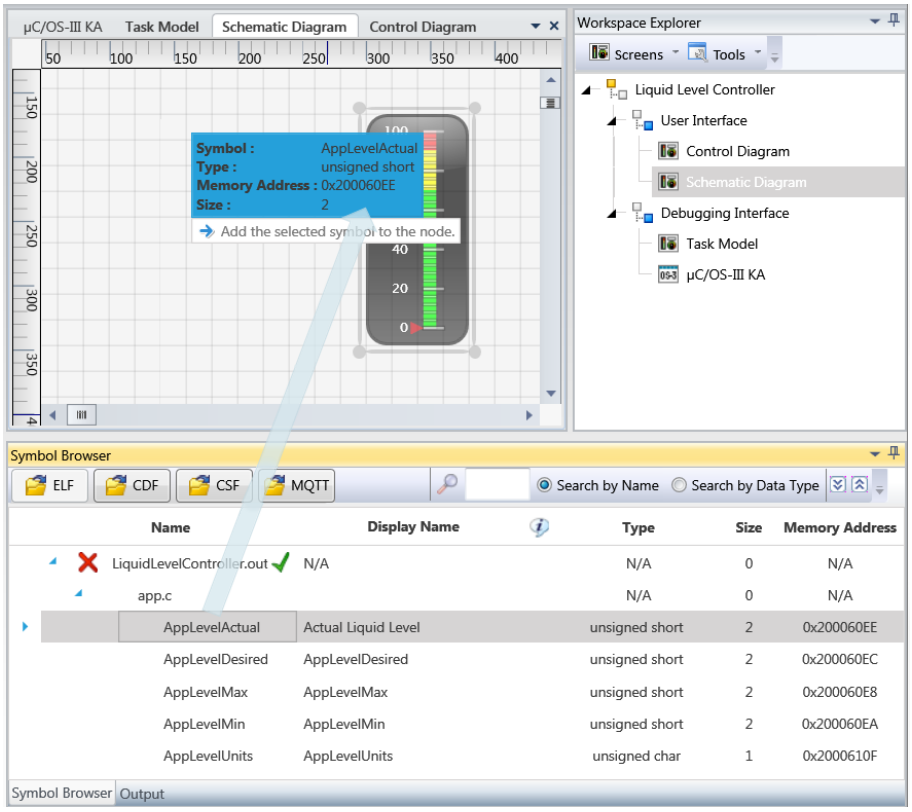



Figure 8-1 **Associating Symbols to Virtual Controls and Indicators**

Repeat the same process for each of the virtual controls and indicators placed on your data screen and µC/Probe will be ready to go into Run Mode unless you want to further configure other optional settings.

In order to configure other optional settings you can use the *symbols manager* by hovering your mouse pointer over the virtual control or indicator and making click on the icon shown in Figure 8-2:

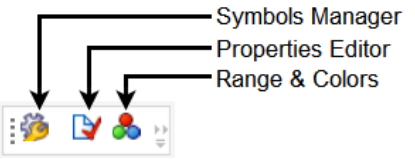



Figure 8-2 **Invoking the Symbols Manager**

Figure 8-3 shows the Symbols Manager:

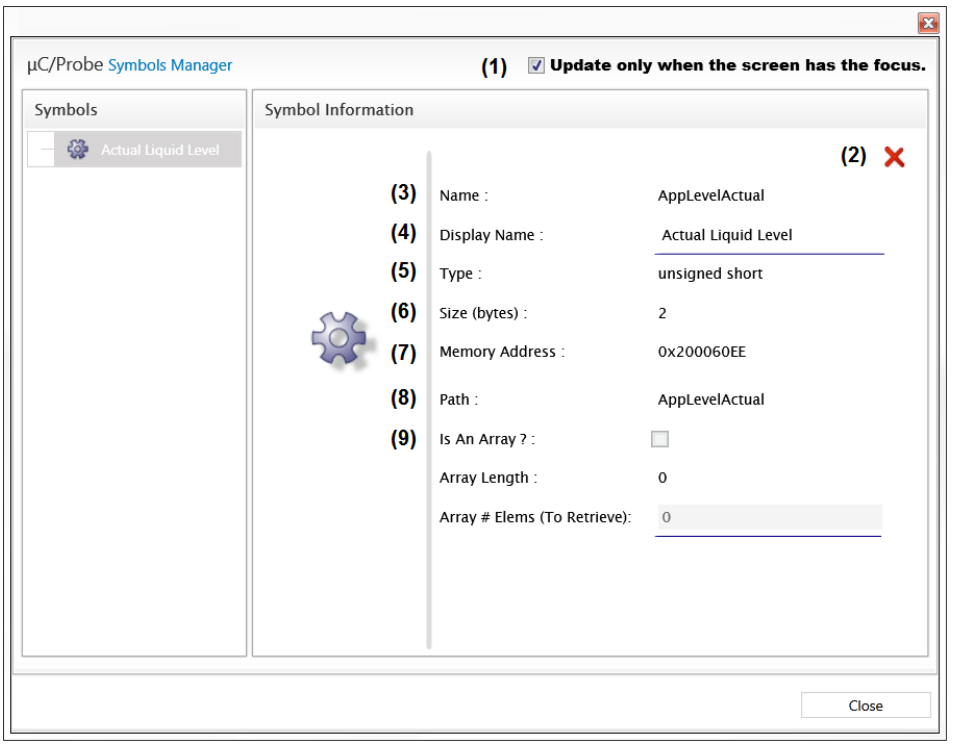



Figure 8-3 **Symbols Manager**

F8-3(1) Tick the checkbox to have µC/Probe update the control's value only when it is visible and in focus.

Untick this checkbox for controls such as charts which you might want to keep updated even when not visible to avoid any gaps in the plot.

F8-3(2) Click the red X to remove the symbol's association from the virtual control or indicator.

F8-3(3) Displays the name of the variable as declared in your C file.

F8-3(4) By default displays the name of the variable as declared in your C file, but this text box allows you to create an alias for display purposes.

F8-3(5) Displays the data type of the variable as declared in your C file.

F8-3(6) Displays the size of the variable in number of bytes.

F8-3(7) Displays the memory location of the variable in the embedded target's memory.

F8-3(8) The variable path displays the full variable name in those cases where the variable you selected is a member of a data structure.

F8-3(9) In case the variable is an array, you can enable indexing of just a certain amount of data.

Chapter

# 9

# Run-Time Mode

## 9-1 RUN-TIME CHECKLIST

Before setting µC/Probe in Run-Time mode you should verify each of the following items:

| Item # | Description | Reference |
|---|---|---|
| 1 | The embedded target has been programmed with an output file (ELF file) with debug information in the DWARF-2, -3 or -4 format or with an XML-based Custom-Symbol File or Chip-Definition File. | µC/Probe Target Manual: Chapter 5, on page 21, Appendix C, on page 55 and Appendix D, on page 61 |
| 2 | The embedded target is running and connected to the Windows PC through the communication interface of your choice. | µC/Probe Target Manual: Chapter 3, on page 14 |
| 3 | µC/Probe has been configured with the latest symbol file (ELF, CDF, CSF or MQTT) that the embedded target is actually running. | µC/Probe User's Manual: Chapter 3, on page 15 |
| 4 | µC/Probe has been configured with the proper communication interface and settings. | µC/Probe User's Manual: Chapter 4, on page 30 |
| 5 | µC/Probe contains at least one virtual control or indicator on the data screen. | µC/Probe User's Manual: Chapter 7, on page 56 |
| 6 | µC/Probe has been configured to associate the virtual control or indicator with one of the embedded target's variables displayed in the symbol browser. | µC/Probe User's Manual: Chapter 8, on page 59 |

Table 9-1 **Run-Time Mode Checklist**

In order to set µC/Probe in Run-Time mode, click on the **run** button indicated in Figure 9-1:

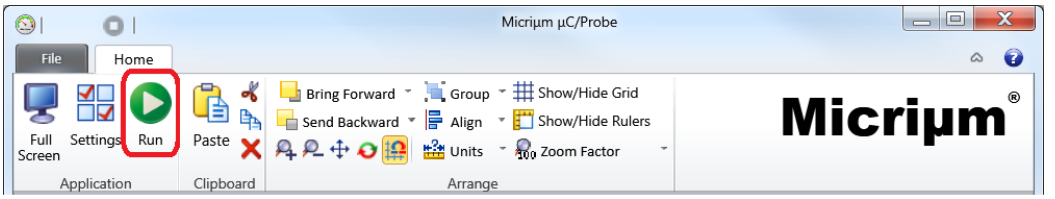



Figure 9-1 **Setting µC/Probe in Run-Time mode**

µC/Probe should start updating your data screens immediately and the application displays all kinds of status information in the status bar at the bottom of the µC/Probe window as shown in Figure 9-2:

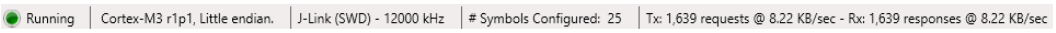

Running
Cortex-M3 r1p1, Little endian.
J-Link (SWD) - 12000 kHz
# Symbols Configured: 25
Tx: 1,639 requests @ 8.22 KB/sec - Rx: 1,639 responses @ 8.22 KB/sec

Figure 9-2 **µC/Probe Status Bar**

## 9-2 RUNNING µC/PROBE AND YOUR DEBUGGING SOFTWARE AT THE SAME TIME

Your debugging software for embedded applications usually comes integrated with your IDE and at a minimum, allows you to step through the code, set breakpoints, display register and memory windows, display call stack information, and monitor variables and expressions. Examples of debugging software include IAR's C-SPY and GNU's GDB.

You can also use µC/Probe to extend the capabilities of your debugging software by running both at the same time. µC/Probe allows you to have instant control over your global variables in a real-time and non-intrusive way. From you debugger software, you can set breakpoints at locations of particular interest in the application being debugged and µC/Probe will stop updating the virtual controls and indicators at the same time.

This feature is accomplished by sharing the connection between the Windows PC and the Embedded Target being debugged. Whether the debugger of your choice is IAR's C-SPY, GNU's GDB or any other debugging software that supports J-Link, Figure 9-3 illustrates and example of running µC/Probe and the debugger of your choice at the same time:

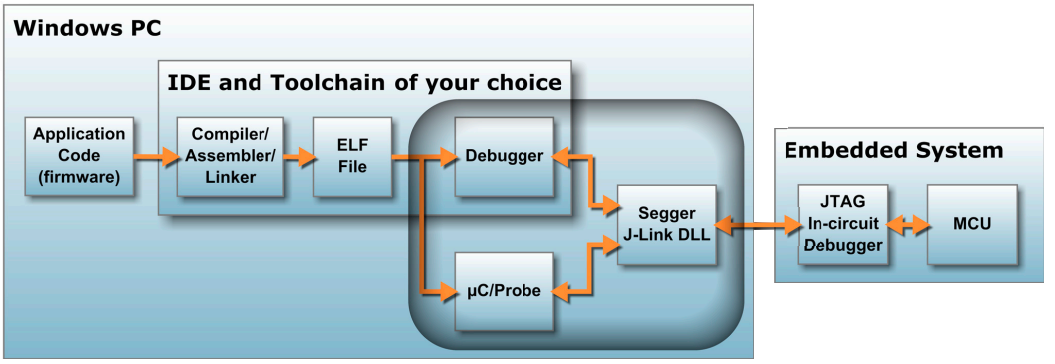



Figure 9-3 **Running µC/Probe and your debugging software at the same time**

Notice how µC/Probe and the Debugger Software not only share the same ELF file but also the same logic and physical interface through the Segger's J-Link DLL and JTAG in-circuit debugger respectively.

## 9-3 IAR SYSTEMS C-SPY PLUGIN FOR µC/PROBE

µC/Probe is tightly integrated with IAR Embedded Workbench® thanks to a TCP/IP bridge between C-SPY® and µC/Probe. This bridge gives µC/Probe access to not only its native supported platforms but also all the devices and processor architectures supported by IAR Systems without the need to write any target resident code in the form of communication routines, because C-SPY® handles all communication needed as illustrated in the following Figure 9-4:

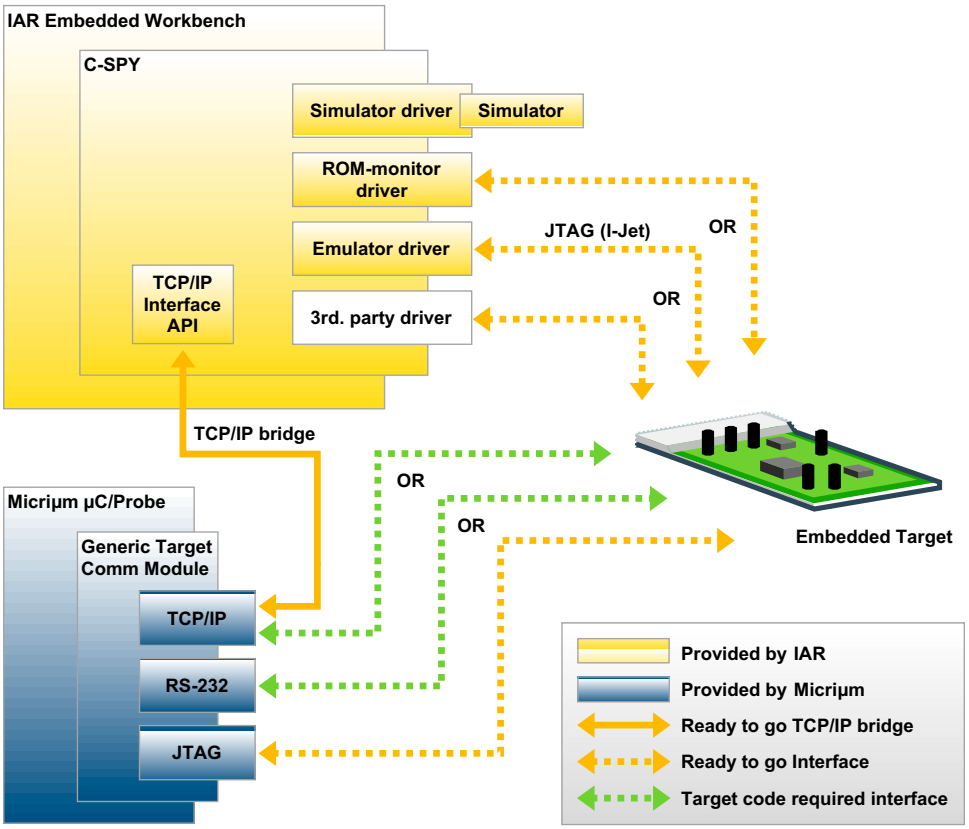



Figure 9-4 **Communication Interfaces Supported by IAR Systems C-SPY and µC/Probe**

In regards to the communication interface options illustrated in Figure 9-4, some of them, such as the ones based on JTAG are ready-to-go assuming your embedded target has either an in-circuit debugger or an external JTAG probe (i.e. IAR's I-Jet). Other communication interfaces require some resident code running in the embedded target, which is available by Micriµm for most platforms.

## 9-3-1 CONFIGURING THE TCP/IP BRIDGE BETWEEN IAR C-SPY AND µC/PROBE

The TCP/IP bridge between C-SPY® and µC/Probe is built in the form of a plugin module delivered with the Embedded Workbench product installation.

In order to configure Embedded Workbench to load the plugin, you open your project's debugger options and select the plugin from the list of available plugins as shown in Figure 9-5:

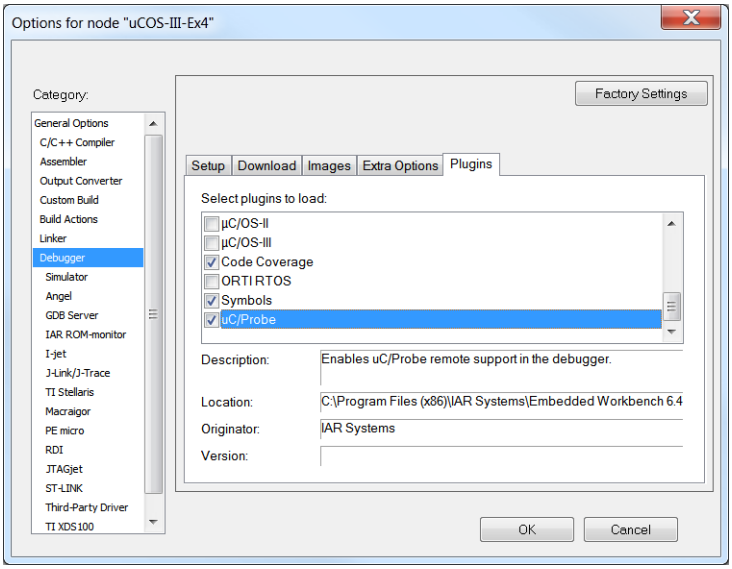



Figure 9-5 **Configuring the IAR Systems Embedded Workbench**

The plugin module gets loaded during a debug session and opens a TCP/IP socket on localhost to listen for µC/Probe requests.

Depending on your network security settings, the first time you launch a debug session you may be asked to allow Embedded Workbench to open a TCP/IP connection.

At the same time, µC/Probe needs to be configured to connect through its TCP/IP interface to localhost on port 9930 as described in section 4-3-5 “TCP/IP” on page 44 and as shown in Figure 9-6:

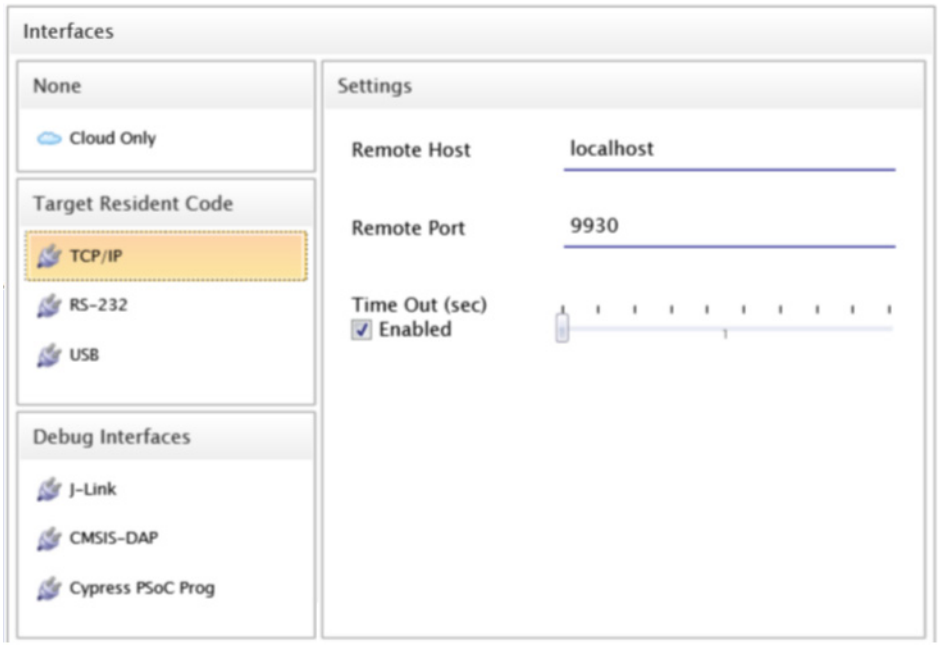



Figure 9-6 **Configuring µC/Probe to Interface with IAR Systems C-SPY plugin for µC/Probe**

Appendix

# A

# Configuring Virtual Controls and Indicators

Once you drag and drop one of the virtual controls or indicators onto the data screen and associate it with one of the embedded target's symbols from the symbol browser, you can access the properties tool bar by moving the mouse over the virtual control or indicator.

The tool bar shown in Figure A-1 appears for you to select between one of the three configuration categories:

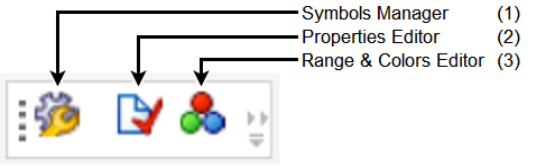



Figure A-1 **Virtual Controls and Indicators Toolbar**

FA-1(1) The Symbols Manager is common for all virtual controls and indicators, see Chapter 8, "Associating Symbols to Virtual Controls and Indicators" on page 59 for more information on the Symbols Manager.

FA-1(2) The Properties Editor is similar among most of the virtual controls and indicators and the next sections will describe how to use the Properties Editor for just a few of the most representative virtual controls and indicators.

FA-1(3) The Range and Colors Editor is only available to those virtual indicators that feature a multi-color scale. The next sections will describe how to use the Range and Colors Editor for a few of the most representative virtual indicators.

# A-1 VIRTUAL INDICATORS

## A-1-1 FORMATTING PROPERTIES EDITOR

The virtual indicators formatting category applies to linear gauges, half donuts, cylinders, numeric indicators, thermometers, graphs and any virtual indicator capable of showing the symbol's value in a graphical or text format. Figure A-2 shows the formatting category of a linear gauge:

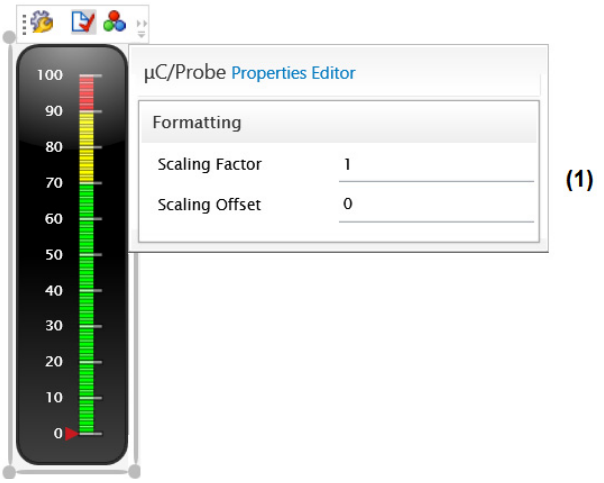



Figure A-2 **Formatting Properties Editor**

FA-2(1) In case you need to convert the value to Engineering Units (EU) before displaying in the virtual indicator, you can use the scaling factor and offset to specify the parameters of a linear conversion function. For example, if the embedded target's symbol you need to display is a 4-20mA value, you can implement the standard linear equation y = mx + b where m is the scaling factor, x is the 4-20mA value, b is the offset and y is the resulting Engineering Units (EU) value to display.

## A-1-2 RANGE AND COLORS EDITOR

The Range and Colors Editor applies to linear gauges, half donuts, cylinders and any virtual indicator capable of displaying the symbol's value in a graphical format along a multi-color scale. Figure A-3 shows the Range and Colors Editor for a linear gauge:

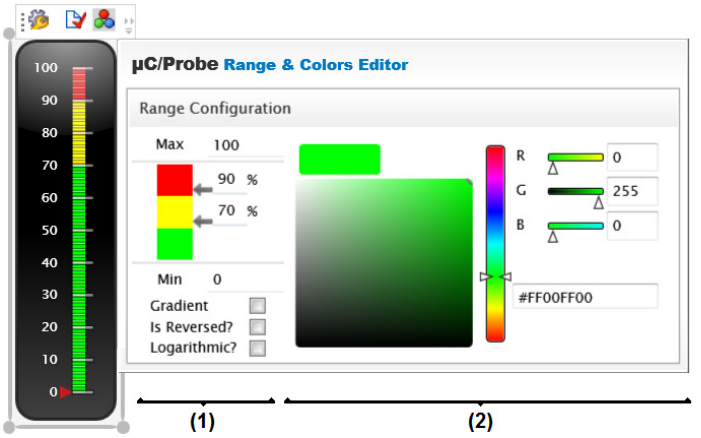



Figure A-3 **Range and Colors Editor**

FA-3(1) Start by setting the **Max** limit, then click on the text boxes next to the percentage signs and enter the thresholds in terms of percentage.

At the bottom of this section, the checkboxes allow you to configure the type of scale and it's appearance.

FA-3(2) Each time you click on one of the text boxes to set the percentages, the color picker allows you to choose the color for that gauge band. You can enter the color you want in hex format or by selecting a color from the vertical slider and then fine tuning with the palette.

## A-1-3 NUMERIC INDICATOR PROPERTIES EDITOR

The Numeric Indicator category from the Properties Editor only applies to numeric indicators. Figure A-4 shows the numeric indicator's properties. Font styles, alignment and the thousand separator, they all apply to the number 0 shown in white:

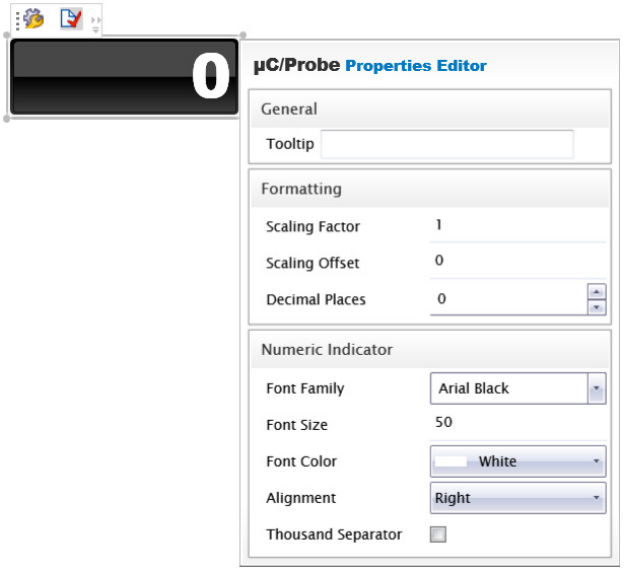



Figure A-4 **Numeric Indicator Properties Editor**

## A-1-4 LED PROPERTIES EDITOR

The LED control allows you to display a circle, triangle or rectangle with its color mapped to the value of one of your embedded target's global variable. This control works as a virtual LED as illustrated in the example in Figure A-5 where the LED control is configured to turn bright red when the value is 1 and dark red when the value is 0.

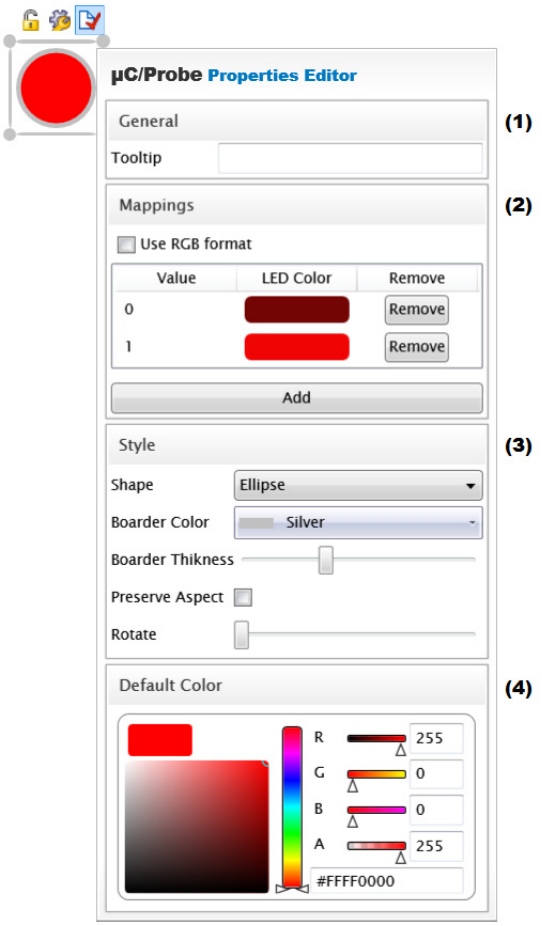



Figure A-5 **LED Properties Editor**

FA-5(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-5(2) The **Mappings** section is where you get to make the association between the LED's color and the value of the symbol.

The checkbox labeled as **Use RGB Format** can be used to associate this control to a global variable that stores a color code encoded in the ARGB additive color model format. The ARGB format is a 32-bit value where each byte is a channel representing the intensity of the channels Alpha, Red, Green and Blue. For example, if the variable's value is 0xFFFFFF00 then the LED would turn Yellow.

FA-5(3) The **Style** section allows you to configure the LED's appearance by modifying the shape and border.

FA-5(4) You can also specify which color to show by default when communication with the embedded target has not been established yet.

## A-1-5 BITMAP ANIMATION PROPERTIES EDITOR

The bitmap animations are part of the toolbox's advanced group. They are one of the most powerful virtual indicators because you have the freedom to customize it however you want by providing your own images.

Imagine you want to display the state of a valve to be either open or closed in a graphical way by using the bitmap images shown in Figure A-6 and an embedded target's application variable named `AppValveOutPct` that stores the state of the outflow valve (0%:open and 100%:closed).

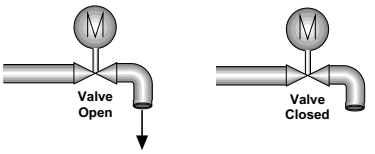



Figure A-6 **Bitmaps to Animate**

Figure A-7 shows the properties editor for the bitmap animation:

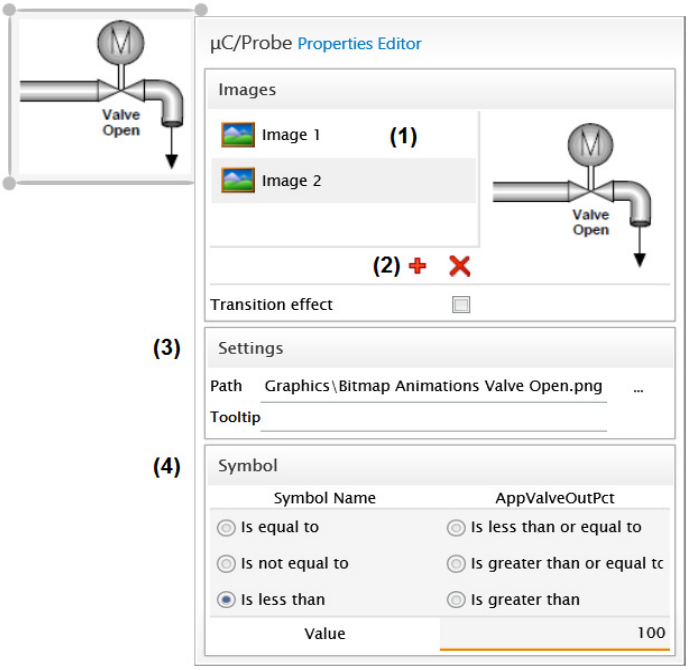



Figure A-7 **Bitmap Animation Properties Editor**

FA-7(1) The list of images is initialized with two images. Start by selecting the image you want to work with. A preview of the image is shown on the right side.

FA-7(2) You can add or delete more images into the list by making click on the red **+** or **x** buttons respectively.

Select the transition effect check box if you want to add a fade-in and fade-out effect between image transitions.

FA-7(3) Specify the bitmap file **Path** or browse to it. Additionally you can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-7(4) Specify the rules. In this case, if `AppValveOutPct < 100` then the valve is open, and if `AppValveOutPct = 100` then the valve is all the way closed.

## A-1-6 AZIMUTH INDICATOR

The Azimuth Indicator or Compass shown in Figure A-8 is the only virtual indicator without a properties editor; that's because you simply map it to a symbol whose value is within 0 and 359, where 0 represents *North*, 90 *East* and so on as illustrated in Figure A-8.

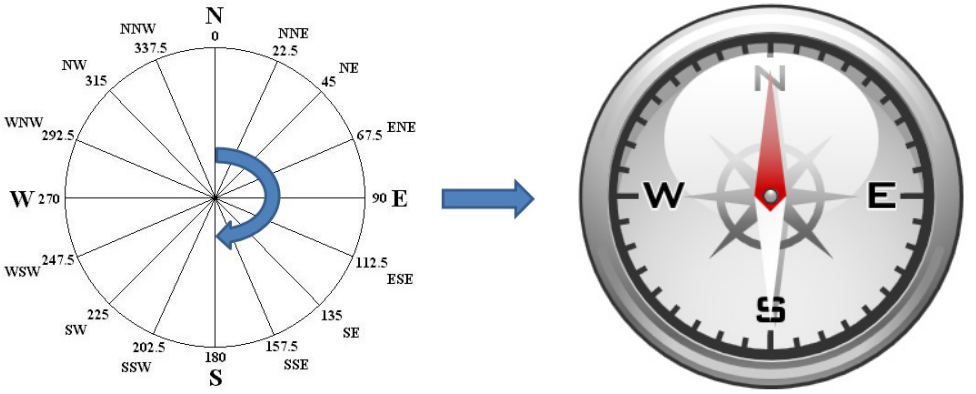



Figure A-8 **Compass**

## A-2 VIRTUAL CONTROLS

### A-2-1 SLIDER CONTROL PROPERTIES EDITOR

The slider control is one of the few writable controls. It allows you to gradually modify an adjustable embedded target symbol's value. The user gets to select from a range of values by moving a value indicator up and down a track. For example, you typically create a volume control by using a slider control.

Figure A-9 shows the slider control properties editor:

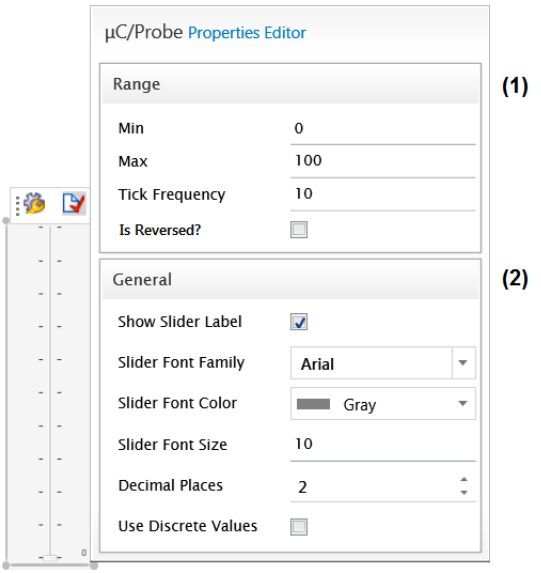



Figure A-9 **Slider Control Properties Editor**

FA-9(1) The slider control has a minimum, a maximum, and an increment value. The **Tick Frequency** not only determines the increment value but also the number of tick marks along the track. You can reverse the scale by ticking the checkbox.

FA-9(2) The **General** category includes the formatting properties that affect the slider's tick labels. Select the check box **Use Discrete Values** if you want the slider to adjust the associated symbol by making discrete increments.

## A-2-2 CUSTOM SLIDER PROPERTIES EDITOR

The custom slider is similar to the one from section A-2-1, except that it also allows you to include two images to the left and right side of the slider's track as shown in Figure A-10:

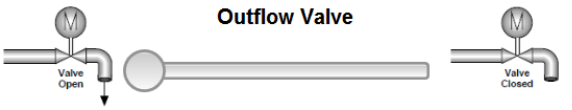



Figure A-10 **Custom Slider Example**

Imagine you want to control the state of a valve to be either open or closed by modifying an embedded target's application variable named `AppValveOutPct` that stores the state of the outflow valve (0%:open and 100%:closed). Figure A-11 shows the custom slider properties editor for such example:.

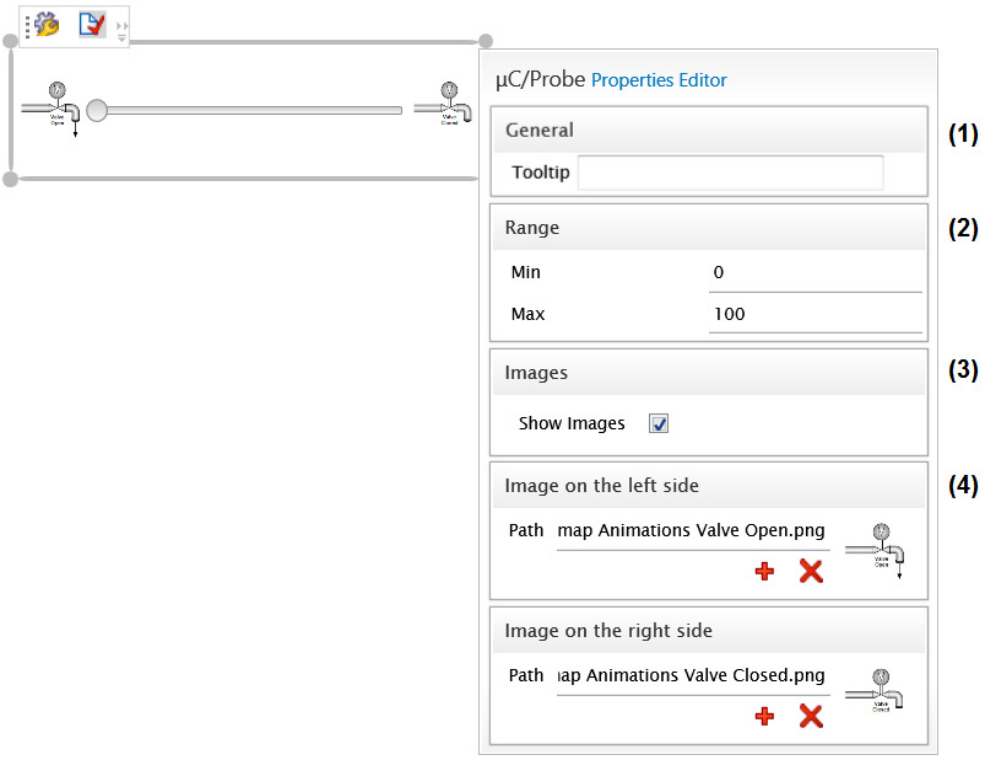



Figure A-11 **Custom Slider Properties Editor**

FA-11(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-11(2) The custom slider control has a minimum and maximum range.

FA-11(3) You can turn on and off the images.

FA-11(4) Specify the path or browse to the bitmap you want to be placed on the left and right sides of the track.

## A-2-3 CUSTOM SWITCH PROPERTIES EDITOR

The custom switch control is a two state button. You can modify the value of an embedded target's symbol by specifying the values you want to write when the button is switched between the **On** and **Off** states as shown in Figure A-12:

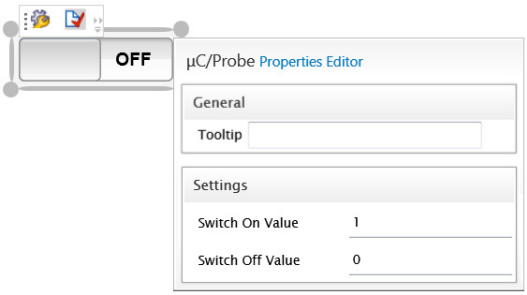



Figure A-12 **Custom Switch Properties Editor**

## A-2-4 CHECKBOX PROPERTIES EDITOR

The checkbox control is similar to the custom switch but it also allows you to specify a label to display when the checkbox is selected and not selected. In the example shown in Figure A-13 such labels are set to Enabled during the On state and Disabled during the Off state.

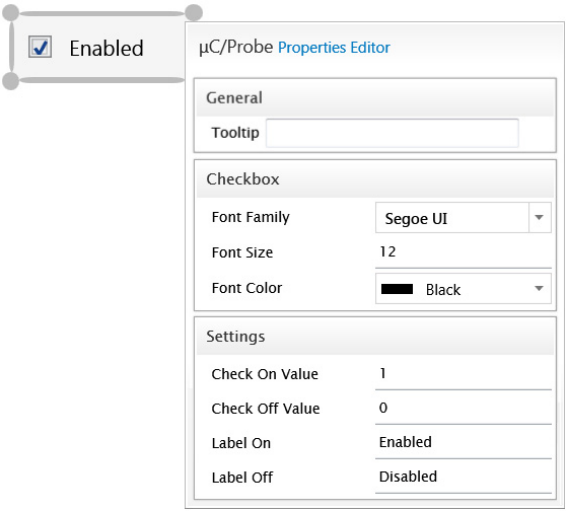



Figure A-13 **Checkbox Properties Editor**

## A-2-5 PUSH BUTTON PROPERTIES EDITOR

The push button control is a momentary switch that switches between the states **On** while held down and **Off** when released. The properties window is shown in Figure A-14.

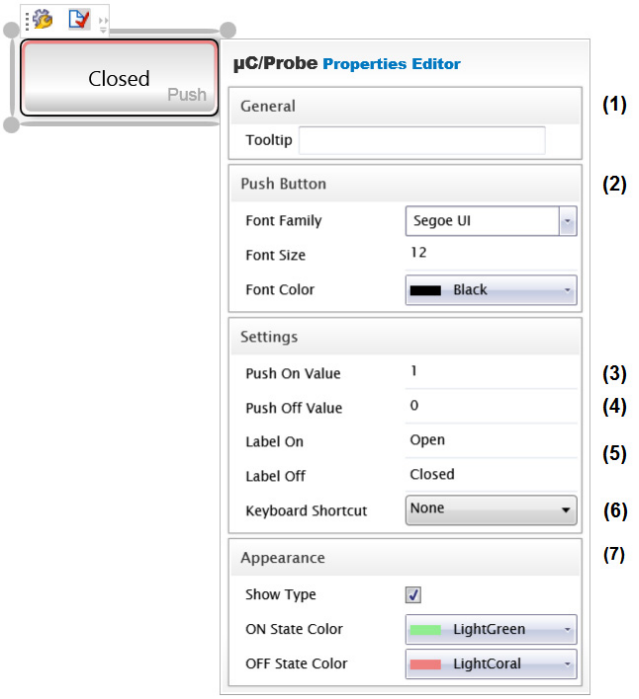



Figure A-14 **Push Button Properties Editor**

FA-14(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-14(2) You can specify the labels to display during the **On** and **Off** states. These properties affect the label's font family, font size and font color properties.

FA-14(3) During run-time, when the user holds down the push button, µC/Probe writes the **Push On Value** one single time to the embedded target.

FA-14(4) When the user releases the button, µC/Probe writes the **Push Off Value** one single time to the embedded target.

FA-14(5) Here you specify the labels you want to display during the **On** and **Off** states.

FA-14(6) The keyboard shortcut is a sequence or combination of keystrokes on the keyboard which will invoke the Click event on the Push Button.

FA-14(7) You can also specify the border colors you want to display during the **On** and **Off** states and whether or not you want to show the **Push** label on the corner.

## A-2-6 TOGGLE BUTTON PROPERTIES EDITOR

The toggle button control is a button that switches between the states **On** and **Off** when clicked. The properties window for a relay's toggle button is shown in Figure A-15:

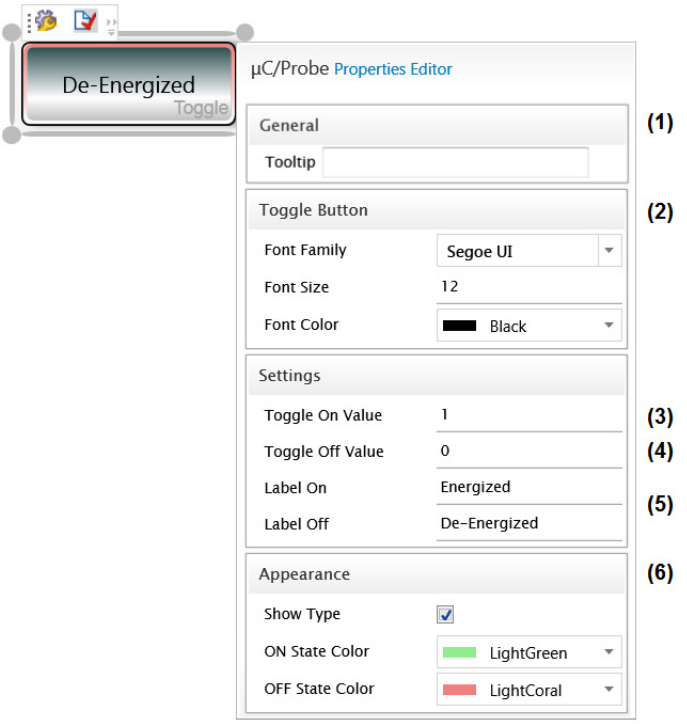



Figure A-15 **Toggle Button Properties Editor**

FA-15(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-15(2) You can specify the labels to display during the **On** and **Off** states. These properties affect the label's font family, font size and font color properties.

FA-15(3) During run-time, when the user clicks and releases the button, µC/Probe writes the **Toggle On Value** one single time to the embedded target.

FA-15(4) When the user clicks and releases the button again, µC/Probe writes the **Toggle Off Value** one single time to the embedded target.

FA-15(5) Here you specify the labels you want to display during the **On** and **Off** states.

FA-15(6) You can specify the border colors you want to display during the **On** and **Off** states and whether or not you want to show the **Toggle** label on the corner.

## A-2-7 REPEAT BUTTON PROPERTIES EDITOR

The repeat button control is a button that switches between the states **On** while held down and **Off** when released. The properties window is shown in Figure A-16:

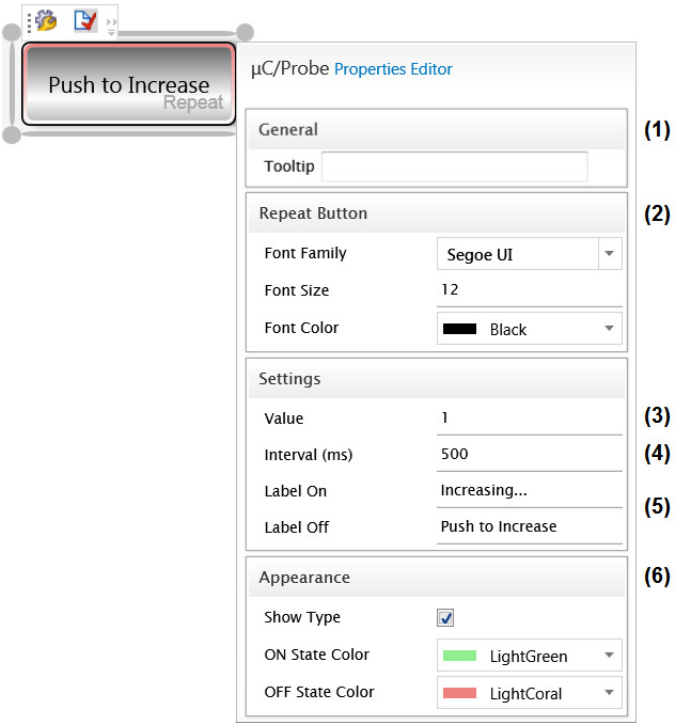



Figure A-16 **Repeat Button Properties Editor**

FA-16(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-16(2) You can specify the labels to display during the **On** and **Off** states. These properties affect the label's font family, font size and font color properties.

FA-16(3) During run-time, when the user holds down the repeat button, µC/Probe writes the **Value** multiple times to the embedded target until the button is released.

FA-16(4) The value gets written to the embedded target multiple times at the specified interval in milliseconds.

FA-16(5) Here you specify the labels you want to display during the **On** and **Off** states.

FA-16(6) You can specify the border colors you want to display during the **On** and **Off** states and whether or not you want to show the **Repeat** label on the corner.

## A-2-8 BIT CONTROL PROPERTIES EDITOR

The bit control is part of the writable controls category in µC/Probe's toolbox. It allows you to read and write to a symbol by either toggling its bits on and off or entering the value in either decimal or hexadecimal format.

This control is perfect to represent peripheral I/O registers and the properties window is shown in Figure A-17:

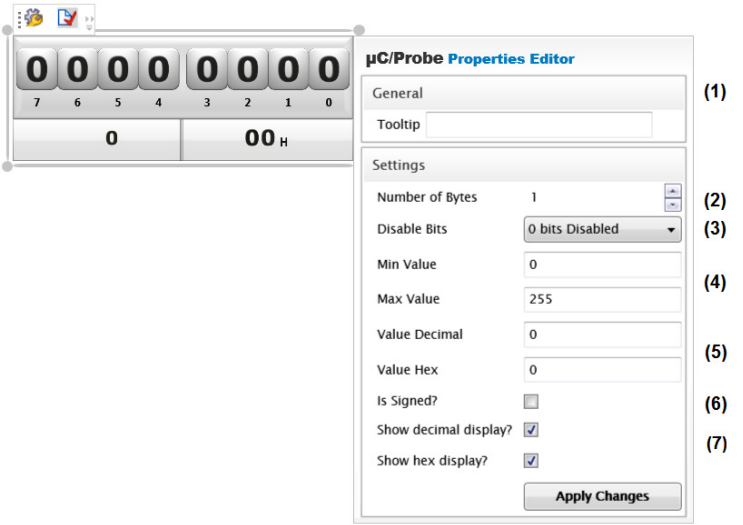



Figure A-17 **Bit Control Properties Editor**

FA-17(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-17(2) You can specify the number of bytes in case you want to override the original data size.

FA-17(3) You can also disable bits, in those cases where some of the bits are reserved which is typically the case with peripheral I/O registers. This drop-down gives you a list of all the bits along with a checkbox to enable and disable each bit.

FA-17(4) You can specify the minimum and maximum value range allowed.

FA-17(5) You can specify an initial value in either decimal or hexadecimal format.

FA-17(6) You can override the data type and specify whether it is signed or unsigned.

FA-17(7) Finally, you can hide the decimal and hexadecimal displays in case you want to show the bit buttons only.

## A-2-9 NUMERIC UP/DOWN CONTROL PROPERTIES EDITOR

The numeric up/down control is part of the writable controls category in µC/Probe's toolbox. It allows you to write a number to the embedded target. It consists of a single line input text field and a pair of arrow buttons for stepping up or down as shown in Figure A-18:

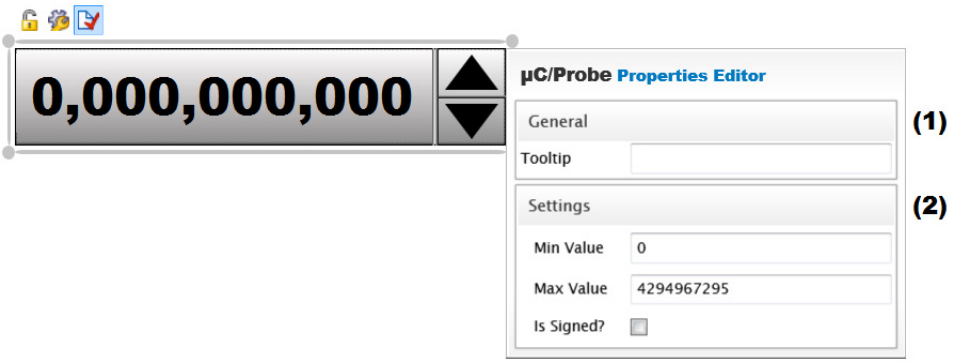



Figure A-18 **Numeric Up/Down Control Properties Editor**

FA-18(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-18(2) You can specify the maximum and minimum range.

## A-2-10 TEXT BOX CONTROL PROPERTIES EDITOR

The text box control is part of the writable controls category in µC/Probe's toolbox. It allows you to write a number to the embedded target. It consists of a single line input text field as shown in Figure A-18:

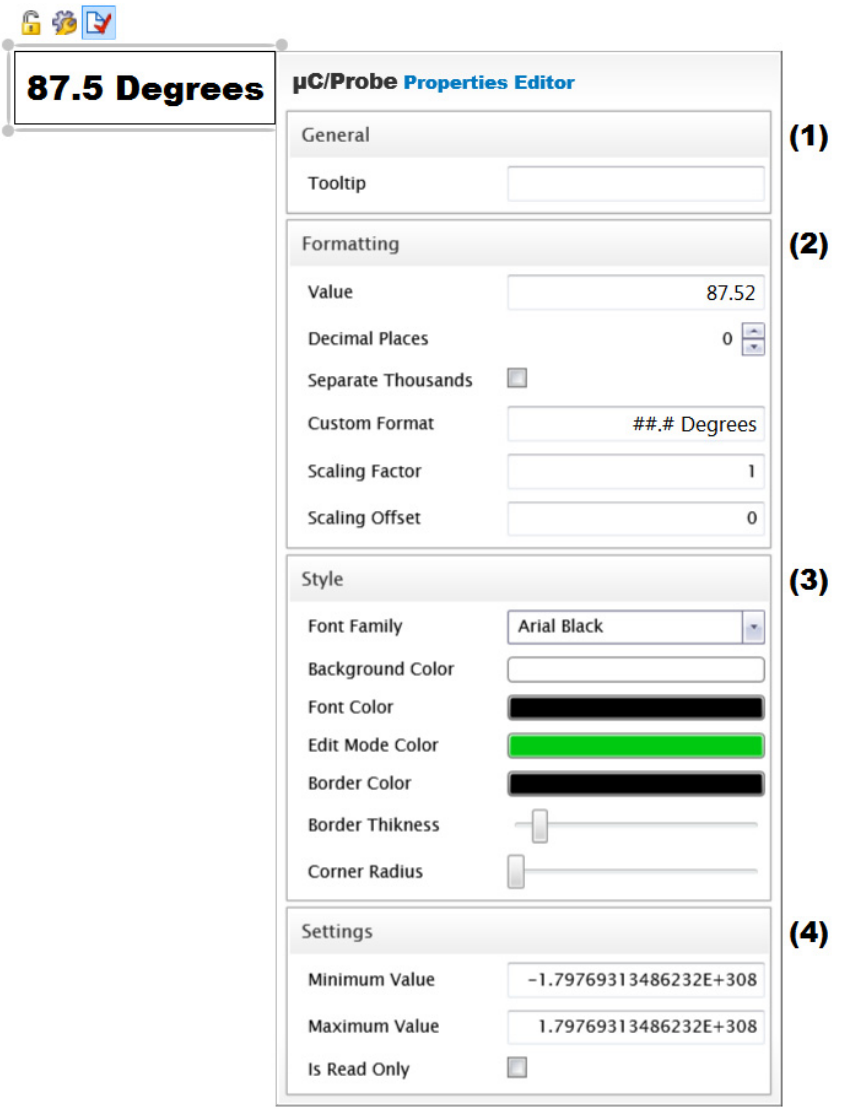



Figure A-19 **Text Box Control Properties Editor**

FA-19(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-19(2) You can specify an initial value, scaling options and a custom format. Standard numeric format strings are used to format common numeric types. A standard numeric format string takes the form Axx, where:

A is a single alphabetic character called the format specifier. Any numeric format string that contains more than one alphabetic character, including white space, is interpreted as a custom numeric format string.

xx is an optional integer called the precision specifier. The precision specifier ranges from 0 to 99 and affects the number of digits in the result. Note that the precision specifier controls the number of digits in the string representation of a number. It does not round the number itself.

Here is some of the most typical examples of custom format strings:

The value 123.456 with a custom format string of "C" results in "$123.46".

The value 1052.0329112756 with a custom format string of "E" results in "1.052033E+003".

The value 255 with a custom format string of "X" results in "FF".

Or, as shown in the example: The value 87.52 with a custom format string of "##.# Degrees" results in "87.5 Degrees".

For more information on custom format strings search the Microsoft documentation on *Custom Format Strings*.

FA-19(3) You can configure the style by modifying font, colors and borders.

FA-19(4) You can also specify the maximum and minimum ranges and whether or not you want to restrict access to read-only.

## A-2-11 RGB COLOR PALETTE PROPERTIES EDITOR

This control is a color picker that allows you to select a color from a palette. When you select a color, the color is encoded in the ARGB additive color model format and written to the associated global variable in the embedded target.

The ARGB format is a 32-bit value where each of the 4 channels (Alpha, Red, Green and Blue) is a number between 0 and 255 that specifies the intensity of each color in the mixture, from fully-off (0) to fully-on (255). The alpha channel represents the opacity of the entire mixture of colors.

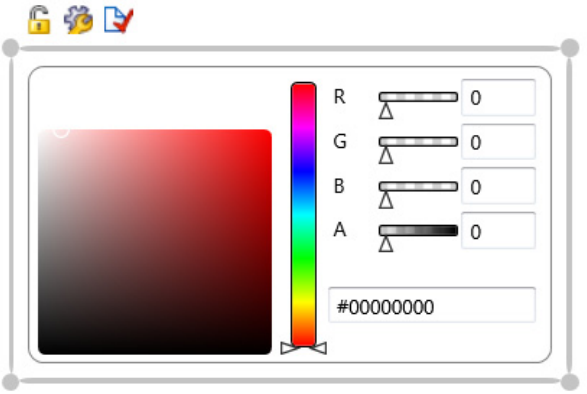



Figure A-20 **RGB Color Palette**

## A-2-12 TREE VIEW PROPERTIES EDITOR

This control is probably one of the most flexible controls to read and write. It allows you to display a data structure in a tree view as shown in Figure A-21:

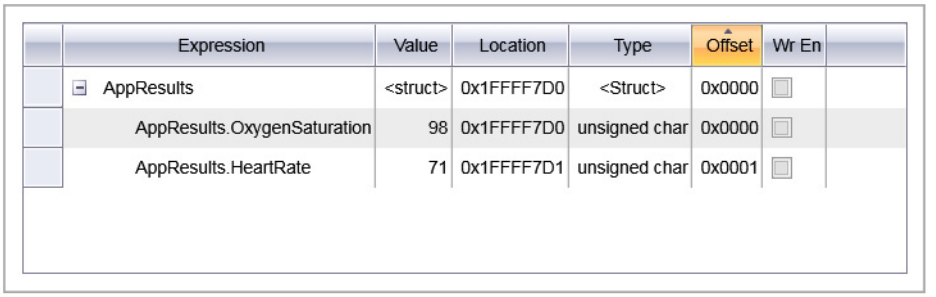



Figure A-21 **Tree View Control**

The properties editor in the tree view control is shown below in Figure A-22:

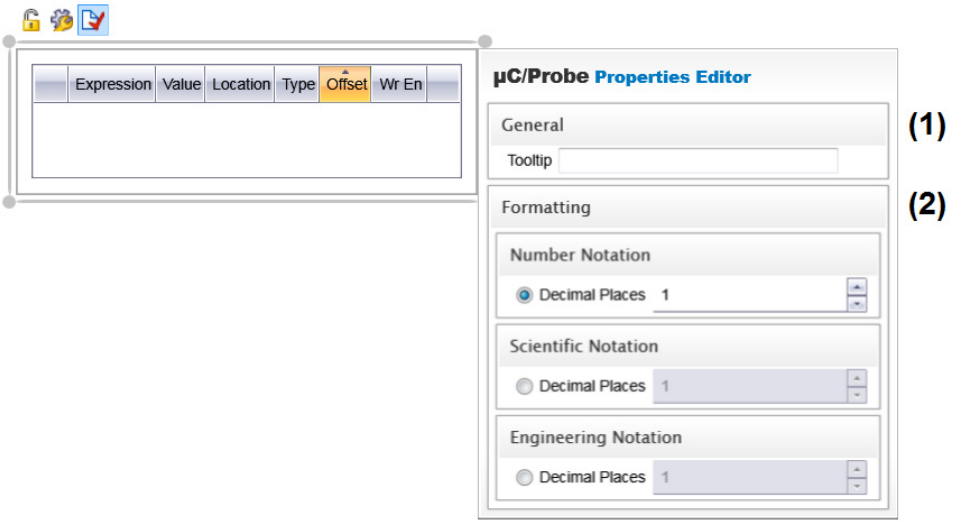



Figure A-22 **Tree View Properties Editor**

FA-22(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-22(2) During run-time you can configure the way each node is displayed. You can select between a decimal and hexadecimal representation. The properties editor in the tree view control allow you to specify the number of decimal places and notation in case the symbol is a float or double.

## A-2-13 RADIO BUTTONS PROPERTIES EDITOR

The radio buttons control is a group of buttons that allow you to select one option from a set. You should use it for optional sets that are mutually exclusive. The radio buttons properties editor is shown in Figure A-23:

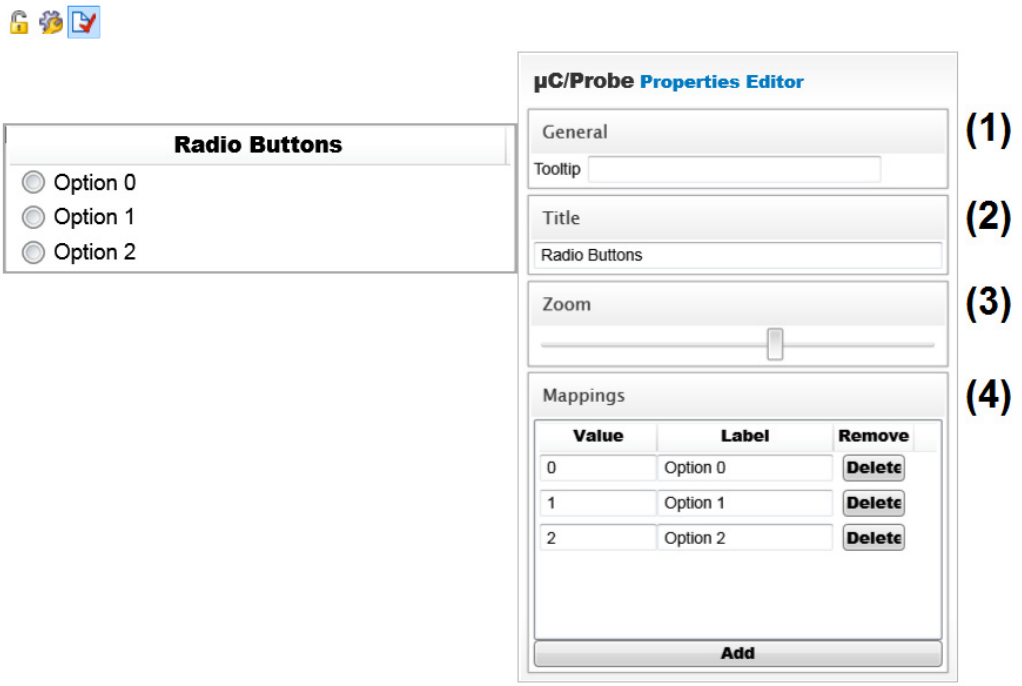



Figure A-23 **Radio Buttons Properties Editor**

FA-23(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-23(2) Here is where you specify the title that appears at the top of your set of options.

FA-23(3) The zoom level controls the font size.

FA-23(4) Here is where you not only provide the name for each option but also the value. Every time the user selects one of the options, the value configured in this section will be written to the associated embedded target symbol.

## A-3 CHARTS

µC/Probe supports two types of charts; timeline charts and scatter x-y charts.

### A-3-1 TIMELINE CHARTS

Timeline charts are those whose samples are considered events in time and the horizontal axis represents the time. Figure A-24 shows the three types of timeline charts supported by µC/Probe:

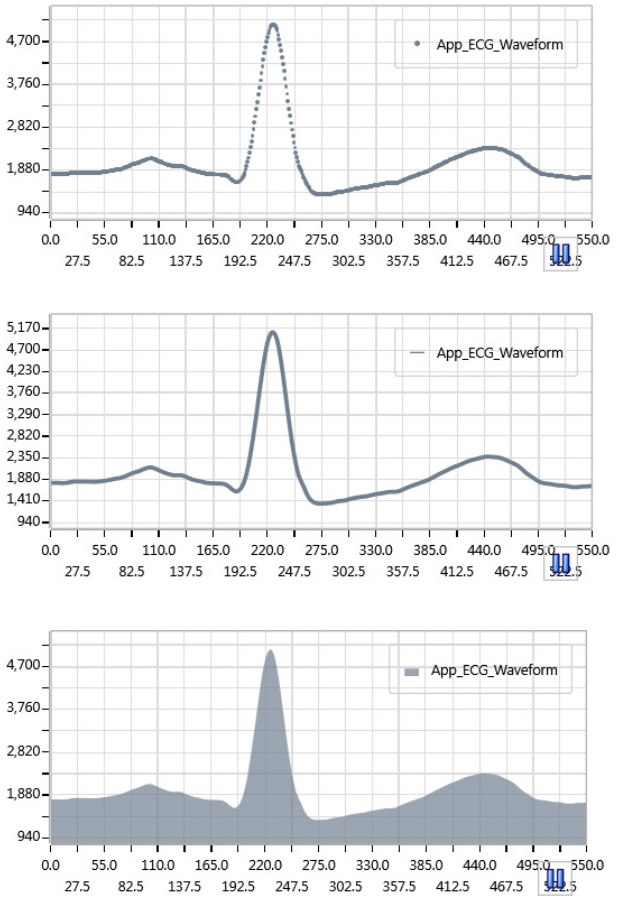



Figure A-24 **Marker, Line and Area Charts**

## TIMELINE CHART PROPERTIES EDITOR

All three timeline chart types share the same properties editor as shown in Figure A-25:

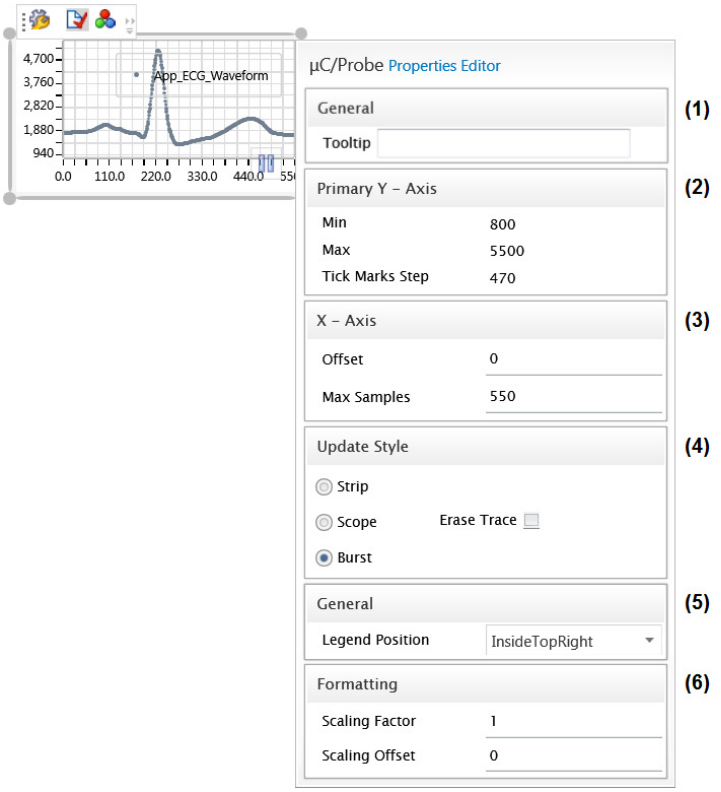



Figure A-25 **Charts Properties Editor**

FA-25(1) You can include an optional **Tooltip** message that will appear with any information you want to display about the item being hovered over.

FA-25(2) In order to change the number at which the vertical axis value starts or ends, enter a different number in the **Min** box or the **Max** box.

In order to change the interval of tick marks and chart grid lines, enter a different number in the **Tick Marks Step** box.

FA-25(3) In order to change the number at which the horizontal axis value starts or ends, enter a different number in the **Offset** box or the **Max Samples** box.

FA-25(4) µC/Probe updates charts in one of three modes:

- **Strip** Mode: similar to a chart recorder device that prints over a paper strip, µC/Probe first plots points from the left to the right side of the chart. From there, any new points are plotted at the rightmost side of the chart by shifting old points to the left.

- **Scope** Mode: similar to an oscilloscope, µC/Probe first plots points from the left to the right side of the chart. Once the plot reaches the right side of the chart, it erases the plot and begins plotting again from the left side of the chart.

- **Burst** Mode: this update mode was made for high performance applications where you want to plot array data quickly by plotting the entire array in one sweep. µC/Probe will not shift any points over the plotting area. Instead, it will erase the plot and will plot the same array again, assuming that the array is being updated by the embedded target.

FA-25(5) µC/Probe supports charts with multiple data series. That means that you can associate multiple symbols from your embedded target into one single chart.

In order to tell which trace represents a symbol in your chart, a color-coded legend with the name of the symbol is displayed over the chart. Select the legend position that better suits your needs.

FA-25(6) In case you need to convert the value points to Engineering Units (EU) before plotting in the chart, you can use the scaling factor and offset to specify the parameters of a linear conversion function. For example, if the embedded target's symbol you need to display is a 4-20mA value, you can implement the standard linear equation y = mx + b where m is the scaling factor, x is the 4-20mA value, b is the offset and y is the resulting Engineering Units (EU) value to be plotted.

## TIMELINE CHART SERIES EDITOR

The charts series editor allows you to configure each trace in the plotting area. The series editor is shared by all three types of charts as shown in Figure A-26:

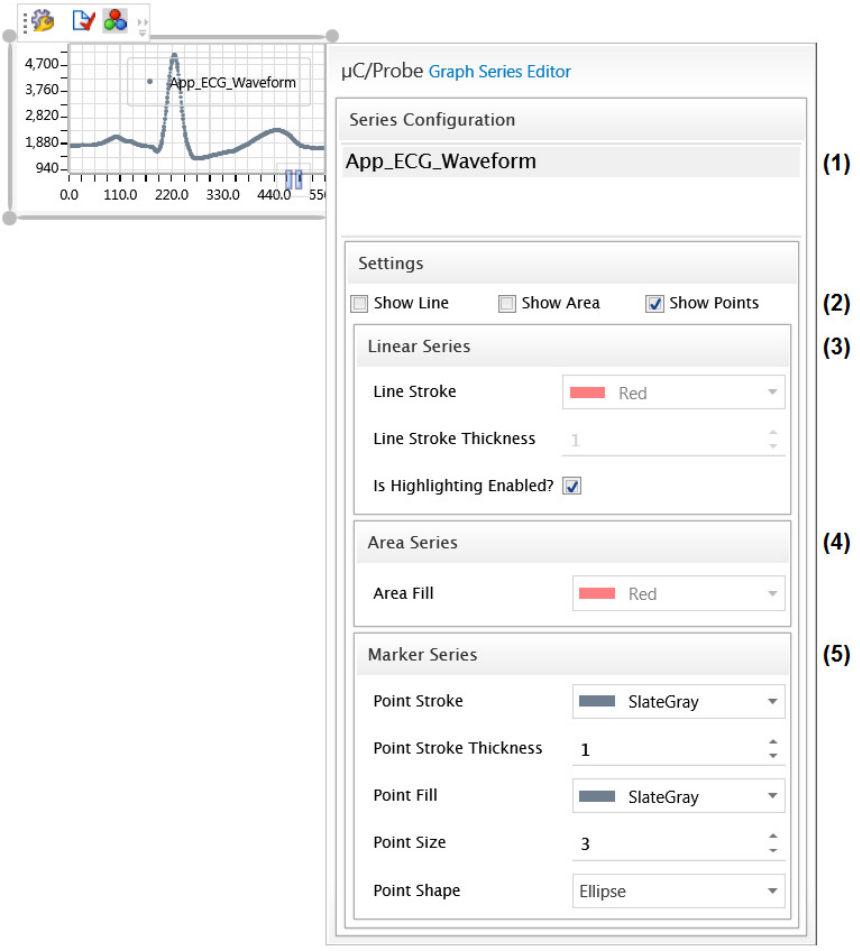



Figure A-26 **Charts Series Editor**

FA-26(1) Select the data series you want to work with. By default, the name of the data series is the same of the symbol as declared in your embedded target C files.

FA-26(2) µC/Probe supports three types of charts: marker, line and area charts. You can mix and match chart types in one single chart by selecting the corresponding check box.

FA-26(3) If the **Show Line** check box is selected, this section allows you to configure the color and thickness of the line.

FA-26(4) If the **Show Area** check box is selected, this section allows you to configure the color of the area.

FA-26(5) If the **Show Points** check box is selected, this section allows you to configure the color, thickness and shape of the points.

## A-3-2 SCATTER X-Y CHARTS

Contrary to timeline charts where the horizontal axis is a representation of time, the scatter x-y charts allow you to use two different arrays to specify the x-y coordinates of each data point.

Use a scatter x-y chart if the data you want to plot includes pairs of values and you want to compare data points without regard of time.

The scatter x-y chart supports two modes of operation; burst and plot mode.

### SCATTER X-Y CHART IN BURST MODE

Use the *burst mode* to compare sets of values stored in two different arrays.

For example, imagine a blood pressure monitor that stores the diastolic pressure in mmHg for each patient. You can use the scatter x-y chart in burst mode to compare the diastolic pressure among the patients age groups as follows.

Code Listing A-1 shows the two arrays that contain the data points.

```
static  const  CPU_INT08U  AppAgeTbl[20] =
{
    20, 28, 32, 45, 26, 64, 23, 54, 32, 54, 23, 33, 44, 21, 43, 52, 56, 62, 23, 45
};

static  const  CPU_INT08U  AppDiastolicPressureTbl[20] =
{
    64, 67, 72, 76, 65, 100, 64, 94, 80, 90, 70, 73, 81, 62, 87, 89, 91, 98, 68, 87
};
```

Listing A-1 **Two Arrays**

First you drag-and-drop an instance of the scatter x-y chart into a data screen. Then you open the symbols file (i.e. ELF file), search for the two arrays `AppAgeTbl[]` and `AppDiastolicPressure[]`, and drag-and-drop the arrays over the scatter x-y chart.

If you open the properties of the chart you will see something similar to Figure A-27:

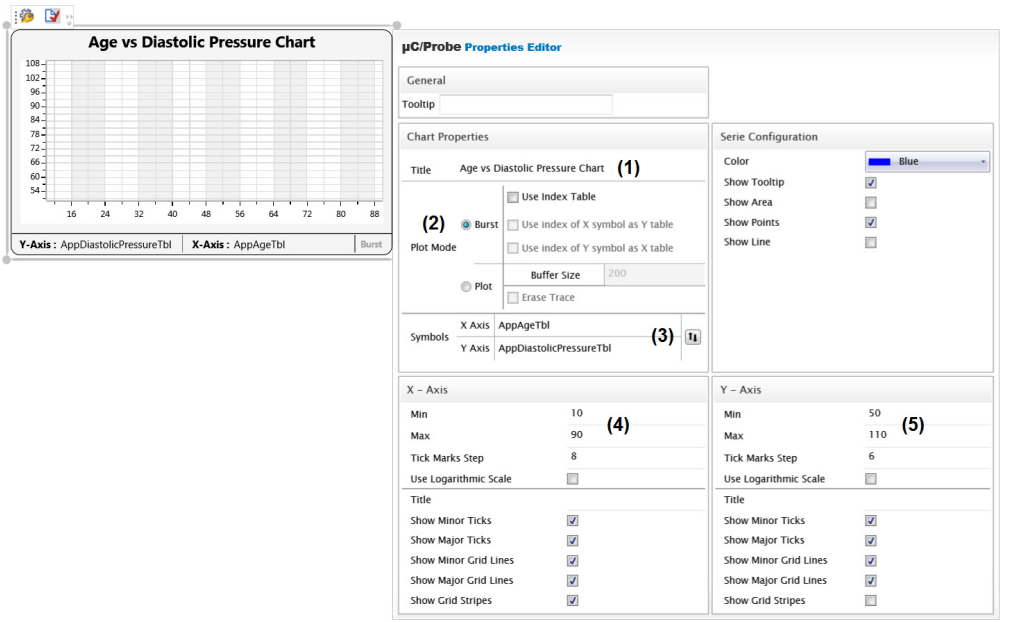



Figure A-27 **Scatter X-Y Chart Properties**

FA-27(1) Enter the title for your scatter x-y chart.

FA-27(2) µC/Probe will automatically set your plot mode to *Burst Mode* in case the axis have been mapped to arrays.

In case you only have one single array and want to use the array indexes as one of the axis, you can enable the checkbox *Use Index Table* and select which axis you want the index to be.

FA-27(3) You can use this button to swap the axis.

FA-27(4) Set the range of your data points over the horizontal axis.

FA-27(5) Set the range of your data points over the vertical axis.

During run-time, µC/Probe and the scatter X-Y chart should plot all the data points at once and will keep refreshing the plot as the values of the arrays change. You should see a scatter chart similar to the one in Figure A-28:

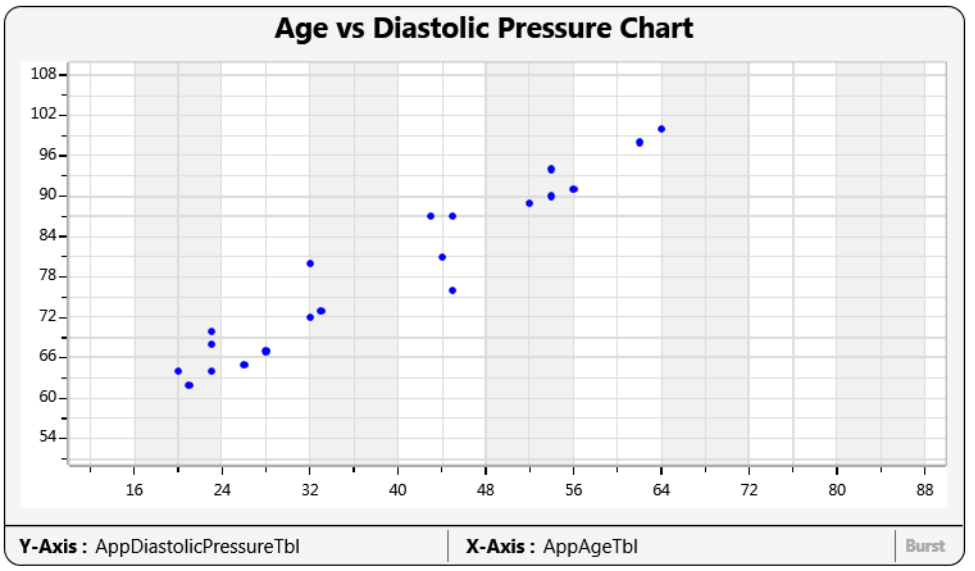



Figure A-28 **Scatter X-Y Chart in Burst Mode**

## SCATTER X-Y CHART IN PLOT MODE

For the *plot mode* of the X-Y scatter chart, imagine for instance you want to monitor in real-time the power curve of a wind turbine. Your embedded application does not buffer any data and instead, it only keeps the current wind speed (meters/sec) and current power (watts) stored in the global variables `AppWindSpd` and `AppPwr` respectively.

Similar to the previous example, you drag-and-drop an instance of the scatter x-y chart into a data screen. Then, you open the symbols file (i.e. ELF file), search for the two variables `AppWindSpd` and `AppPwr`, and drag-and-drop the them over the scatter x-y chart.

If you open the properties of the chart you will see something similar to Figure A-29:

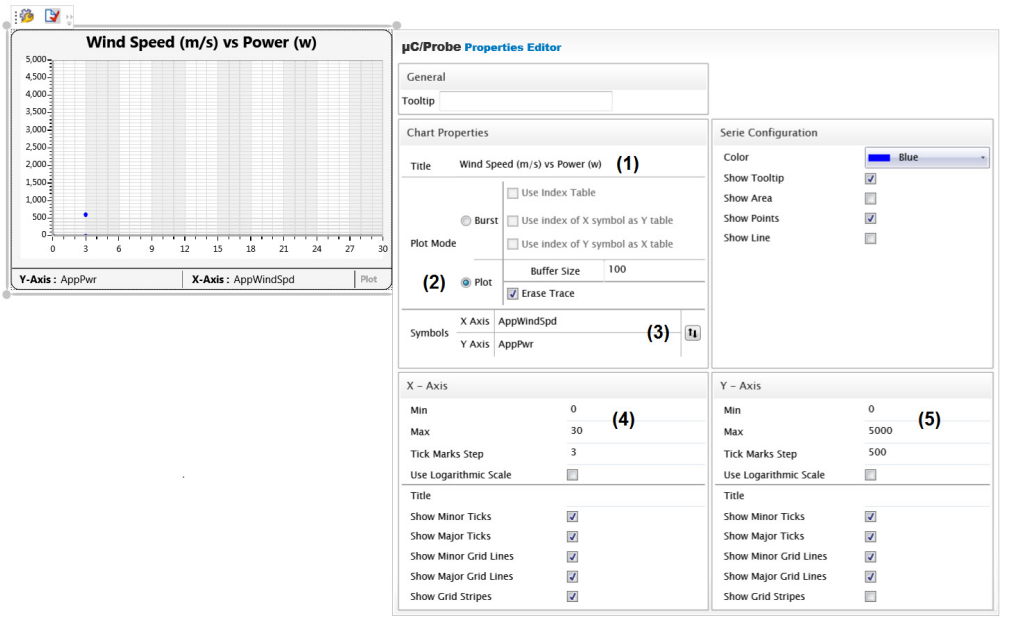



Figure A-29 **Scatter X-Y Chart Properties**

FA-29(1) Enter the title for your scatter x-y chart.

FA-29(2) µC/Probe will automatically set your chart to *Plot Mode* in case the axis have been mapped to a pair of non-array variables.

In this case, you need to specify the size of the host-side buffer that will hold the pair of values and whether or not you want the entire plot to be erased once the buffer is full.

FA-29(3) You can use this button to swap the axis.

FA-29(4) Set the range of your data points over the horizontal axis.

FA-29(5) Set the range of your data points over the vertical axis.

During run-time, the scatter chart should start to fill the plot area with one data point at a time and at the coordinate (`AppWindSpd`, `AppPwr`). Depending on the data change rate and the data collection rate, eventually the chart should look similar to the one in Figure A-30:

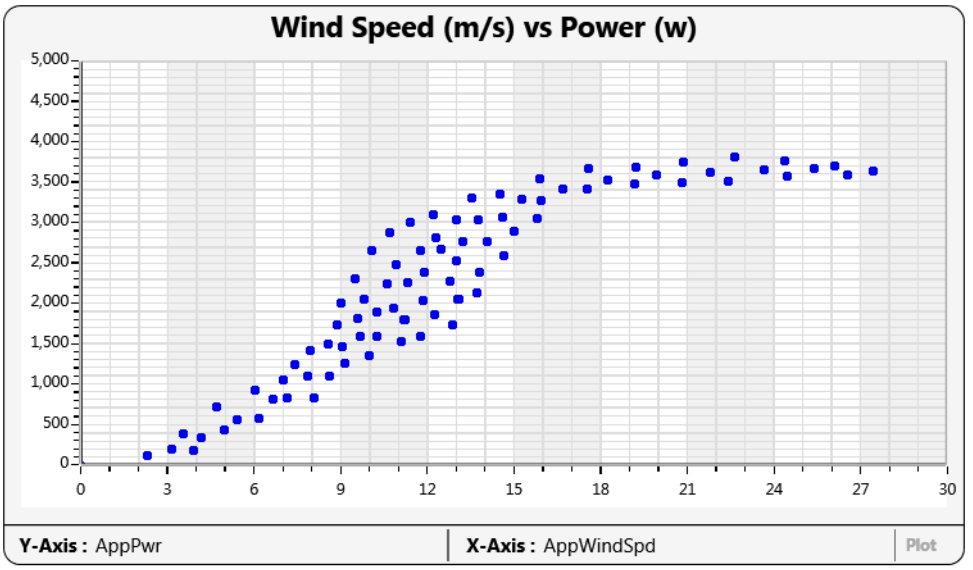



Figure A-30 **Scatter X-Y Chart in Plot Mode**

Appendix

# B

# Micriμm Software Awareness Screens

μC/Probe allows you to add pre-configured data screens that display some of the most popular Micriμm's software modules such as μC/OS-II, μC/OS-III and the μC/TCP-IP stack.

## B-1 KERNEL AWARENESS SCREENS

The following images, show examples of the Kernel Awareness Screens for μC/OS-II and μC/OS-III. The Screens display each kernel's internal data structures in a convenient series of windows. This provides you with information about each of the active tasks in the embedded target application among other kernel objects such as semaphores, message queues, event flags, mutexes, etc.

### B-1-1 μC/OS-II REQUIREMENTS

In order to display the μC/OS-II Awareness Screens you have to configure and initialize a few things in your C project:

- Make sure **OS_DBG_EN** is set to 1u
- Make sure **OS_TASK_STAT_EN** is set to 1u
- Make sure **CPU_CFG_INT_DIS_MEAS_EN** is set to 1u
- You need to provide a *timestamp* timer which is used to measure delta time between events such as task execution time, CPU usage on a per-task basis, etc.

For ARM Cortex-M, we use the *cycles counter* and for Renesas RX, we typically use **CMT1**. Ideally, they should be an 'UP' timer as fast as the CPU cycles but in some cases could be in the few MHz range. Implementation details are typically found in **CPU_TS_TmrInit()** and **BSP_TS_TmrInit()**.

- Call **CPU_IntDisMeasMaxCurReset()** in the first task that starts (after **BSP_Init()** and **CPU_Init()**)
- Call **OSStatInit()** in the first task that starts (after **BSP_Init()** and **CPU_Init()**)
- Make sure optimization is set to LOW because the tools will remove unused variables which could be needed for debug.

## B-1-2 µC/OS-II KERNEL AWARENESS SCREENS

The µC/OS-II Kernel Awareness Screens include the following:

- Task List
- Semaphores
- Mailboxes
- Mutexes
- Message Queues
- Memory Partitions
- Timers
- Event Flags
- Configuration Constants

The following images show some of them.

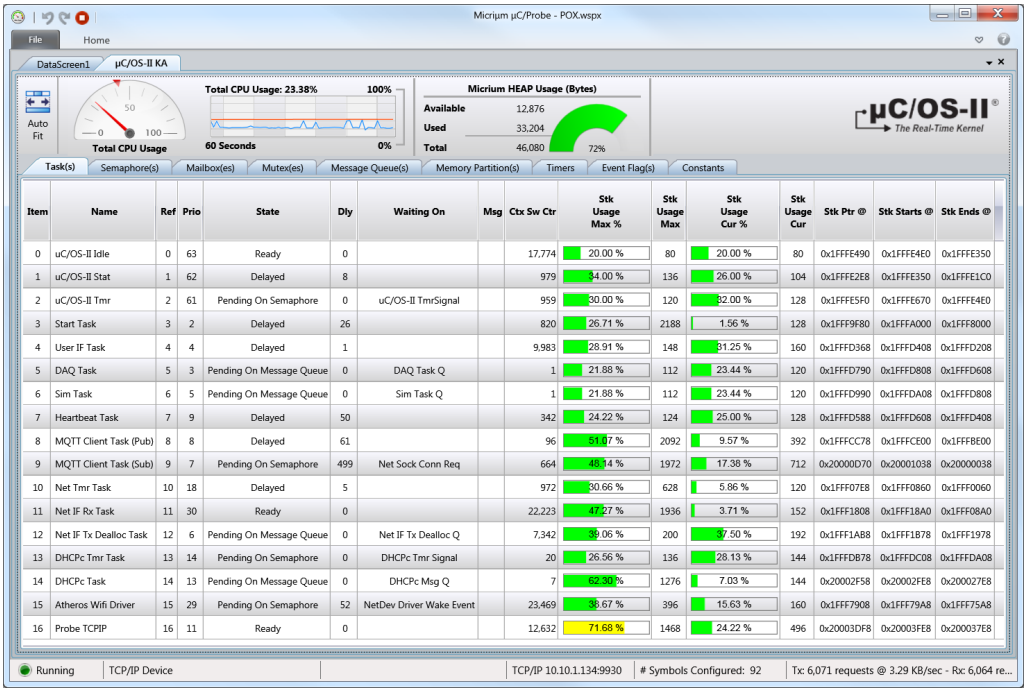

Micrium µC/Probe - POX.wspx
File
Home
DataScreen1
µC/OS-II KA
Auto Fit
Total CPU Usage
Total CPU Usage: 23.38%
100%
60 Seconds
0%
Micrium HEAP Usage (Bytes)
Available 12,876
Used 33,204
Total 46,080
72%
µC/OS-II
The Real-Time Kernel
Task(s)
Semaphore(s)
Mailbox(es)
Mutex(es)
Message Queue(s)
Memory Partition(s)
Timers
Event Flag(s)
Constants
Item | Name | Ref | Prio | State | Dly | Waiting On | Msg | Ctx Sw Ctr | Stk Usage Max % | Stk Usage Max | Stk Usage Cur % | Stk Usage Cur | Stk Ptr @ | Stk Starts @ | Stk Ends @
0 | uC/OS-II Idle | 0 | 63 | Ready | 0 | | | 17,774 | 20.00 % | 80 | 20.00 % | 80 | 0x1FFFE490 | 0x1FFFE4E0 | 0x1FFFE350
1 | uC/OS-II Stat | 1 | 62 | Delayed | 8 | | | 979 | 34.00 % | 136 | 26.00 % | 104 | 0x1FFFE2E8 | 0x1FFFE350 | 0x1FFFE1C0
2 | uC/OS-II Tmr | 2 | 61 | Pending On Semaphore | 0 | uC/OS-II TmrSignal | | 959 | 30.00 % | 120 | 32.00 % | 128 | 0x1FFFE5F0 | 0x1FFFE670 | 0x1FFFE4E0
3 | Start Task | 3 | 2 | Delayed | 26 | | | 820 | 26.71 % | 2188 | 1.56 % | 128 | 0x1FFF9F80 | 0x1FFFA000 | 0x1FFF8000
4 | User IF Task | 4 | 4 | Delayed | 1 | | | 9,983 | 28.91 % | 148 | 31.25 % | 160 | 0x1FFFD368 | 0x1FFFD408 | 0x1FFFD208
5 | DAQ Task | 5 | 3 | Pending On Message Queue | 0 | DAQ Task Q | | 1 | 21.88 % | 112 | 23.44 % | 120 | 0x1FFFD790 | 0x1FFFD808 | 0x1FFFD608
6 | Sim Task | 6 | 5 | Pending On Message Queue | 0 | Sim Task Q | | 1 | 21.88 % | 112 | 23.44 % | 120 | 0x1FFFD990 | 0x1FFFDA08 | 0x1FFFD808
7 | Heartbeat Task | 7 | 9 | Delayed | 50 | | | 342 | 24.22 % | 124 | 25.00 % | 128 | 0x1FFFD588 | 0x1FFFD608 | 0x1FFFD408
8 | MQTT Client Task (Pub) | 8 | 8 | Delayed | 61 | | | 96 | 51.07 % | 2092 | 9.57 % | 392 | 0x1FFFCC78 | 0x1FFFCE00 | 0x1FFFBE00
9 | MQTT Client Task (Sub) | 9 | 7 | Pending On Semaphore | 499 | Net Sock Conn Req | | 664 | 48.14 % | 1972 | 17.38 % | 712 | 0x20000D70 | 0x20001038 | 0x20000038
10 | Net Tmr Task | 10 | 18 | Delayed | 5 | | | 972 | 30.66 % | 628 | 5.86 % | 120 | 0x1FFF07E8 | 0x1FFF0860 | 0x1FFF0060
11 | Net IF Rx Task | 11 | 30 | Ready | 0 | | | 22,223 | 47.27 % | 1936 | 3.71 % | 152 | 0x1FFF1808 | 0x1FFF18A0 | 0x1FFF08A0
12 | Net IF Tx Dealloc Task | 12 | 6 | Pending On Message Queue | 0 | Net IF Tx Dealloc Q | | 7,342 | 39.06 % | 200 | 37.50 % | 192 | 0x1FFF1AB8 | 0x1FFF1B78 | 0x1FFF1978
13 | DHCPc Tmr Task | 13 | 14 | Pending On Semaphore | 0 | DHCPc Tmr Signal | | 20 | 26.56 % | 136 | 28.13 % | 144 | 0x1FFFDB78 | 0x1FFFDC08 | 0x1FFFDA08
14 | DHCPc Task | 14 | 13 | Pending On Message Queue | 0 | DHCPc Msg Q | | 7 | 62.30 % | 1276 | 7.03 % | 144 | 0x20002F58 | 0x20002FE8 | 0x200027E8
15 | Atheros Wifi Driver | 15 | 29 | Pending On Semaphore | 52 | NetDev Driver Wake Event | | 23,469 | 38.67 % | 396 | 15.63 % | 160 | 0x1FFF7908 | 0x1FFF79A8 | 0x1FFF75A8
16 | Probe TCPIP | 16 | 11 | Ready | 0 | | | 12,632 | 71.68 % | 1468 | 24.22 % | 496 | 0x20003DF8 | 0x20003FE8 | 0x200037E8
Running
TCP/IP Device
TCP/IP 10.10.1.134:9930
# Symbols Configured: 92
Tx: 6,071 requests @ 3.29 KB/sec - Rx: 6,064 re...

Figure B-1 **µC/OS-II Kernel Awareness Screen: Task List**

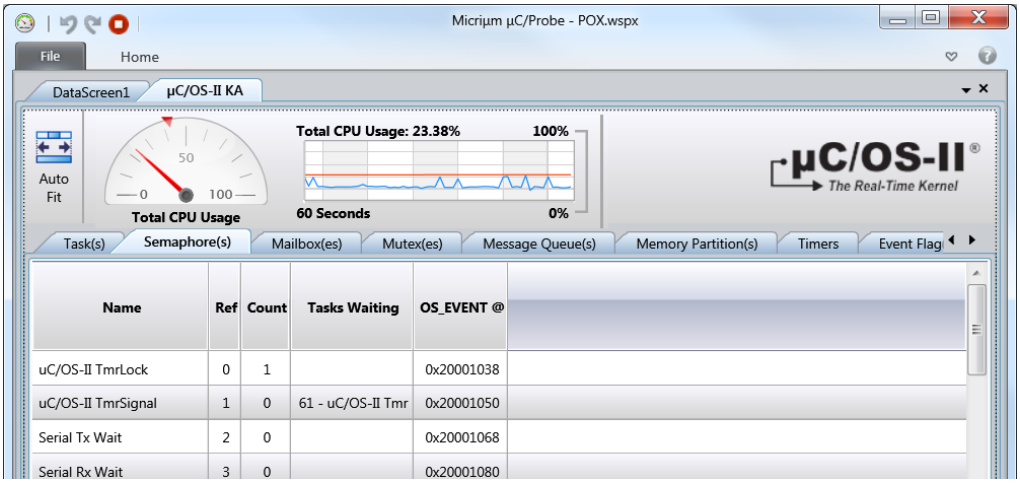



Figure B-2 **µC/OS-II Kernel Awareness Screen: Semaphores List**

## B-1-3 µC/OS-III REQUIREMENTS

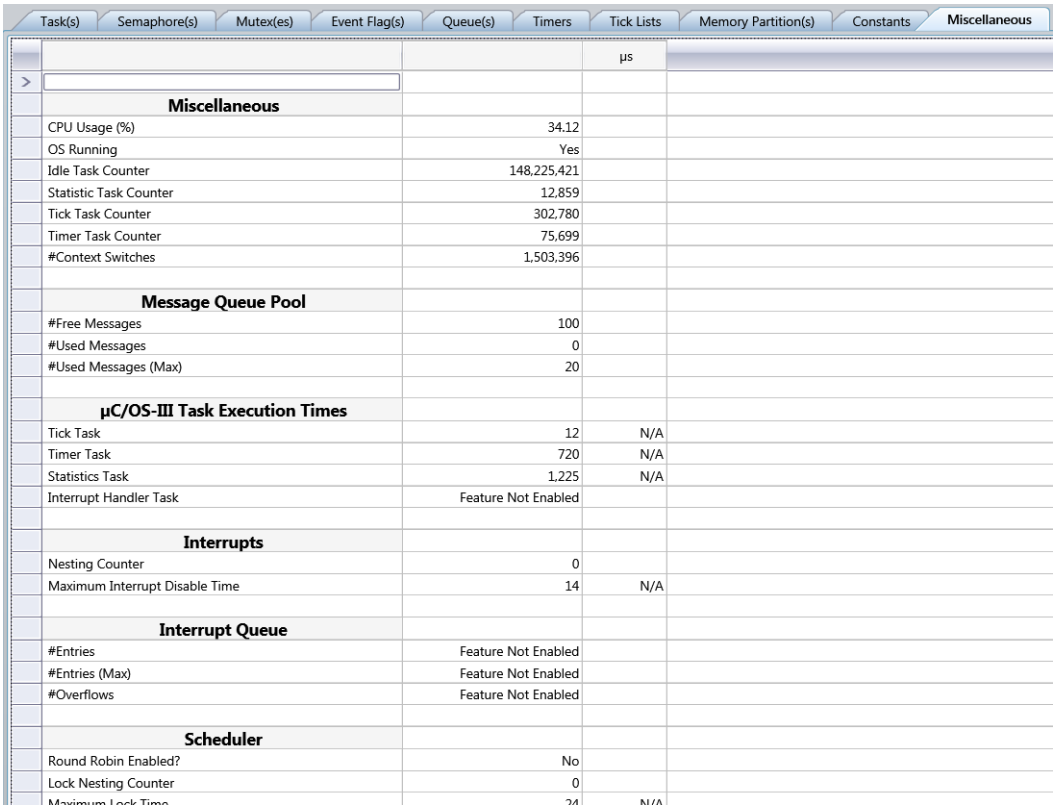
Similar to µC/OS-II, in order to display the µC/OS-III Awareness Screens you have to configure and initialize a few things in your C project:

- Make sure **OS_CFG_DBG_EN** is set to **DEF_ENABLED**
- Make sure **OS_CFG_STAT_TASK_EN** is set to **DEF_ENABLED**
- Make sure **OS_CFG_TASK_PROFILE_EN** is set to **DEF_ENABLED**
- Make sure **CPU_CFG_INT_DIS_MEAS_EN** is set to **DEF_ENABLED**
- You need to provide a *timestamp* timer which is used to measure delta time between events such as task execution time, CPU usage on a per-task basis, etc.

  For ARM Cortex-M, we use the *cycles counter* and for Renesas RX, we typically use **CMT1**. Ideally, they should be an 'UP' timer as fast as the CPU cycles but in some cases could be in the few MHz range. Implementation details are typically found in **CPU_TS_TmrInit()** and **BSP_TS_TmrInit()**.
- Call **OSStatTaskCPUUsageInit()** in the first task that starts (after **BSP_Init()** and **CPU_Init()**)
- Call **CPU_IntDisMeasMaxCurReset()** in the first task that starts (after **BSP_Init()** and **CPU_Init()**)
- Call **OSStatReset()** in the first task that starts (after **BSP_Init()** and **CPU_Init()**)
- Make sure optimization is set to LOW because the tools will remove unused variables which could be needed for debug.

## B-1-4 µC/OS-III KERNEL AWARENESS SCREENS

The 10 screens are organized in a tabular view as shown in Figure B-3:



Task(s) | Semaphore(s) | Mutex(es) | Event Flag(s) | Queue(s) | Timers | Tick Lists | Memory Partition(s) | Constants | Miscellaneous

| | | µs |
|---|---|---|
| **Miscellaneous** | | |
| CPU Usage (%) | 34.12 | |
| OS Running | Yes | |
| Idle Task Counter | 148,225,421 | |
| Statistic Task Counter | 12,859 | |
| Tick Task Counter | 302,780 | |
| Timer Task Counter | 75,699 | |
| #Context Switches | 1,503,396 | |
| **Message Queue Pool** | | |
| #Free Messages | 100 | |
| #Used Messages | 0 | |
| #Used Messages (Max) | 20 | |
| **µC/OS-III Task Execution Times** | | |
| Tick Task | 12 | N/A |
| Timer Task | 720 | N/A |
| Statistics Task | 1,225 | N/A |
| Interrupt Handler Task | Feature Not Enabled | |
| **Interrupts** | | |
| Nesting Counter | 0 | |
| Maximum Interrupt Disable Time | 14 | N/A |
| **Interrupt Queue** | | |
| #Entries | Feature Not Enabled | |
| #Entries (Max) | Feature Not Enabled | |
| #Overflows | Feature Not Enabled | |
| **Scheduler** | | |
| Round Robin Enabled? | No | |
| Lock Nesting Counter | 0 | |
| Maximum Lock Time | 24 | N/A |

Figure B-3 **Kernel Awareness Screen: Miscellaneous**

Figure B-4 shows the information displayed for each task. The columns can be sorted and the tri-color bar graphs highlight those tasks reaching their maximum stack space, which is a typical bug when developing embedded systems:

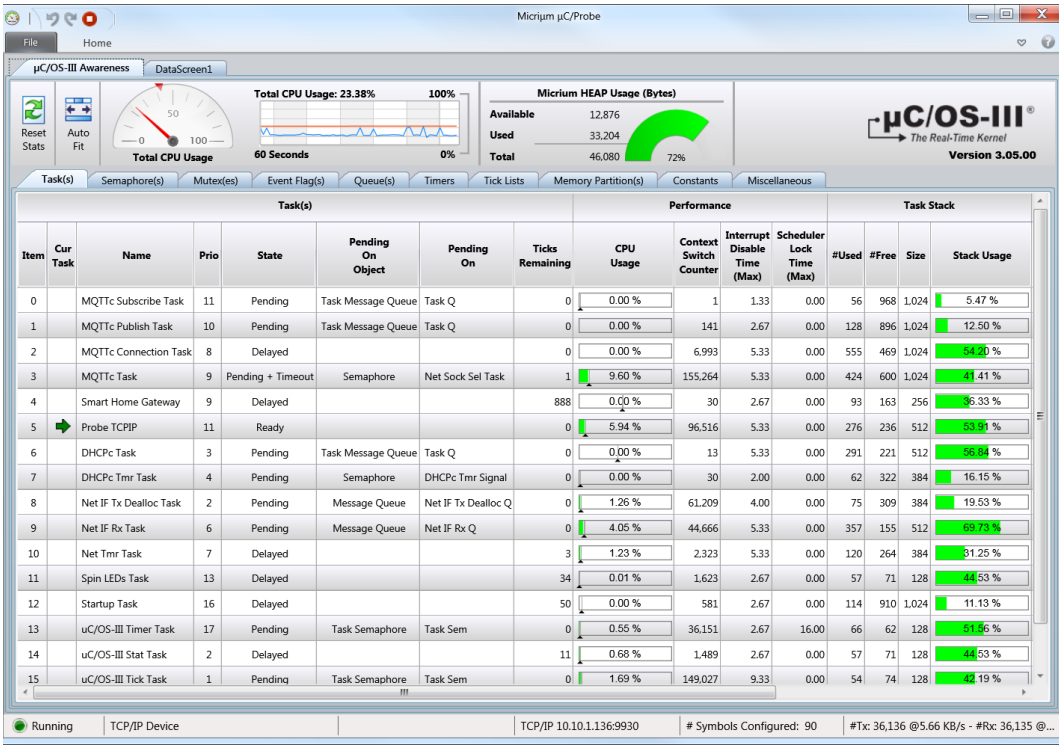

Micrium µC/Probe
File
Home
µC/OS-III Awareness
DataScreen1
Reset Stats
Auto Fit
Total CPU Usage
Total CPU Usage: 23.38%
100%
60 Seconds
0%
Micrium HEAP Usage (Bytes)
Available 12,876
Used 33,204
Total 46,080
72%
µC/OS-III
The Real-Time Kernel
Version 3.05.00
Task(s)
Semaphore(s)
Mutex(es)
Event Flag(s)
Queue(s)
Timers
Tick Lists
Memory Partition(s)
Constants
Miscellaneous
Task(s)
Performance
Task Stack
Item
Cur Task
Name
Prio
State
Pending On Object
Pending On
Ticks Remaining
CPU Usage
Context Switch Counter
Interrupt Disable Time (Max)
Scheduler Lock Time (Max)
#Used
#Free
Size
Stack Usage
0 MQTTc Subscribe Task 11 Pending Task Message Queue Task Q 0 0.00 % 1 1.33 0.00 56 968 1,024 5.47 %
1 MQTTc Publish Task 10 Pending Task Message Queue Task Q 0 0.00 % 141 2.67 0.00 128 896 1,024 12.50 %
2 MQTTc Connection Task 8 Delayed 0 0.00 % 6,993 5.33 0.00 555 469 1,024 54.20 %
3 MQTTc Task 9 Pending + Timeout Semaphore Net Sock Sel Task 1 9.60 % 155,264 5.33 0.00 424 600 1,024 41.41 %
4 Smart Home Gateway 9 Delayed 888 0.00 % 30 2.67 0.00 93 163 256 36.33 %
5 Probe TCPIP 11 Ready 0 5.94 % 96,516 5.33 0.00 276 236 512 53.91 %
6 DHCPc Task 3 Pending Task Message Queue Task Q 0 0.00 % 13 5.33 0.00 291 221 512 56.84 %
7 DHCPc Tmr Task 4 Pending Semaphore DHCPc Tmr Signal 0 0.00 % 30 2.00 0.00 62 322 384 16.15 %
8 Net IF Tx Dealloc Task 2 Pending Message Queue Net IF Tx Dealloc Q 0 1.26 % 61,209 4.00 0.00 75 309 384 19.53 %
9 Net IF Rx Task 6 Pending Message Queue Net IF Rx Q 0 4.05 % 44,666 5.33 0.00 357 155 512 69.73 %
10 Net Tmr Task 7 Delayed 3 1.23 % 2,323 5.33 0.00 120 264 384 31.25 %
11 Spin LEDs Task 13 Delayed 34 0.01 % 1,623 2.67 0.00 57 71 128 44.53 %
12 Startup Task 16 Delayed 50 0.00 % 581 2.67 0.00 114 910 1,024 11.13 %
13 uC/OS-III Timer Task 17 Pending Task Semaphore Task Sem 0 0.55 % 36,151 2.67 16.00 66 62 128 51.56 %
14 uC/OS-III Stat Task 2 Delayed 11 0.68 % 1,489 2.67 0.00 57 71 128 44.53 %
15 uC/OS-III Tick Task 1 Pending Task Semaphore Task Sem 0 1.69 % 149,027 9.33 0.00 54 74 128 42.19 %
Running
TCP/IP Device
TCP/IP 10.10.1.136:9930
# Symbols Configured: 90
#Tx: 36,136 @5.66 KB/s - #Rx: 36,135 @...

Figure B-4 **Kernel Awareness Screen: Task List**

## B-1-5 ADDING A KERNEL AWARENESS SCREEN

To include a kernel awareness screen in your µC/Probe workspace, first make sure you load the ELF file as described in Chapter 3, “Loading an ELF file” on page 16. Then you can go to the **Workspace Explorer** on the right hand side and click on the button **Screens** and select either **µC/OS-II** or **µC/OS-III** kernel awareness screen as illustrated in Figure B-5:

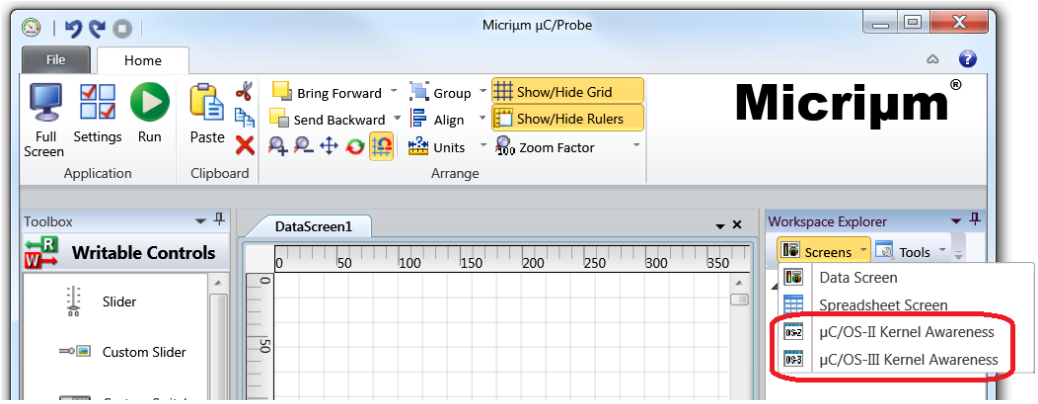



Figure B-5 **Kernel Awareness Screens**

## B-2 µC/TCP-IP AWARENESS SCREENS

This includes a series of screens that display the run-time state of the µC/TCP-IP stack including:

- Stack Layers Overview
- TCP Resources and Statistics
- UDP Resources and Statistics
- ARP Resources and Statistics
- IP Statistics
- Socket Resources and Status List
- Connection Resources and Statistics
- Timer Resources and Statistics
- Interface Resources and Statistics

The information in these screens allows you to optimize the performance and footprint of your µC/TCP-IP stack. Here are some screen captures:

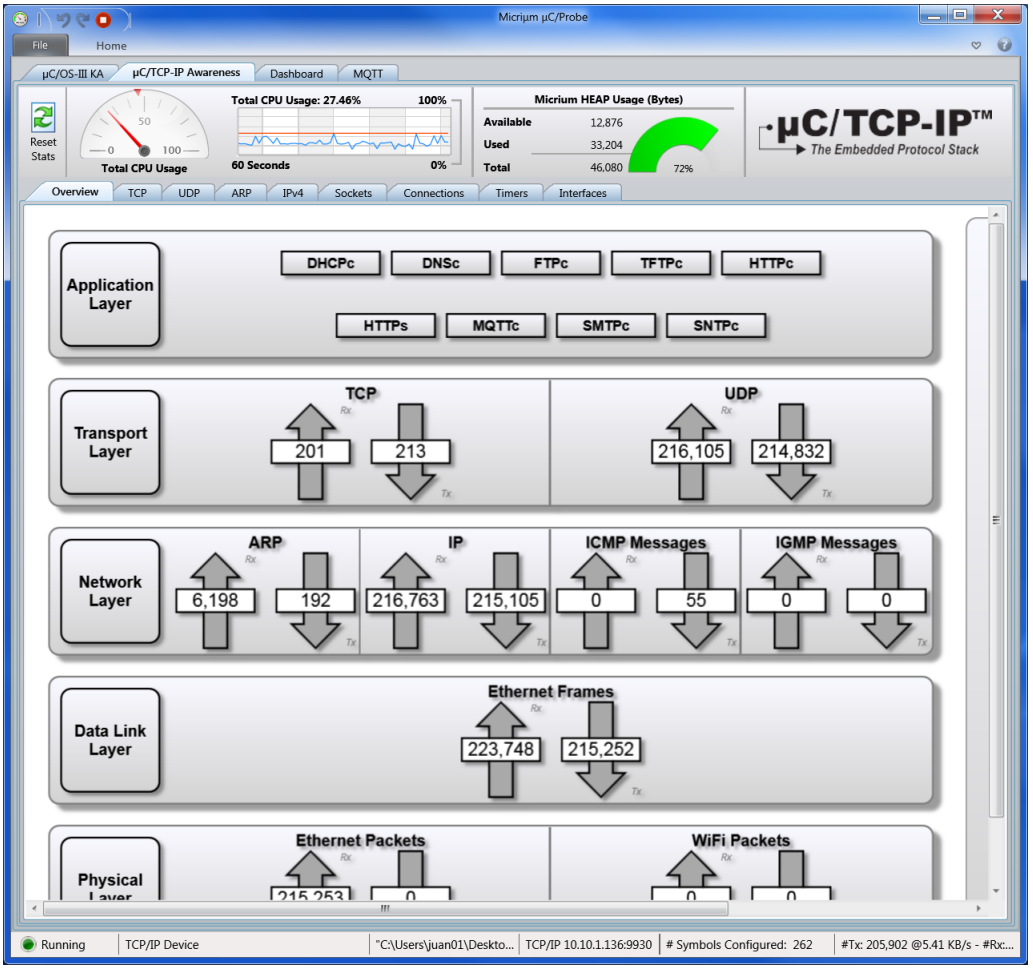



Figure B-6 **µC/TCP-IP Awareness Screens: Overview**

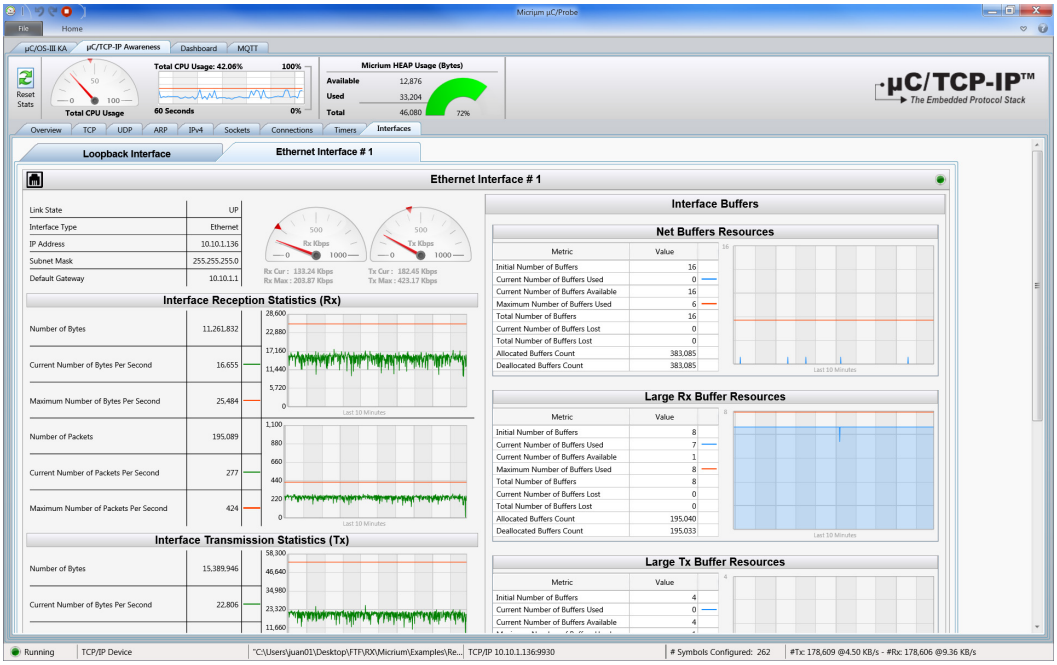



Figure B-7 **µC/TCP-IP Awareness Screens: Interfaces**

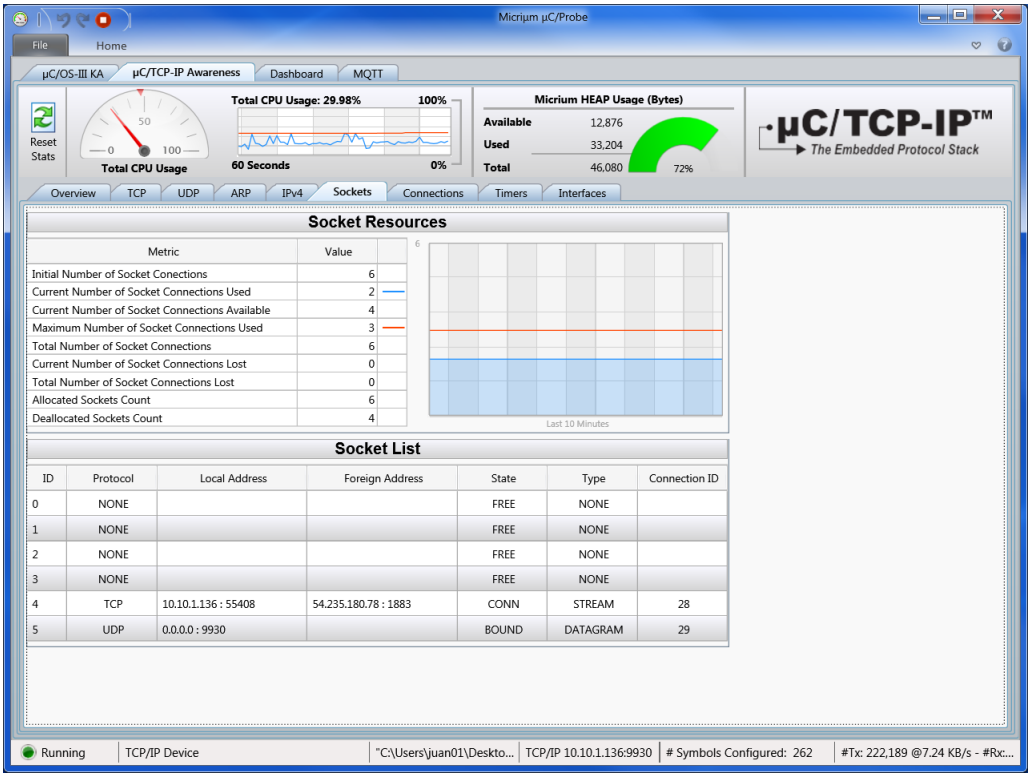



Figure B-8 **µC/TCP-IP Awareness Screens: Sockets**

## B-2-1 ADDING A µC/TCP-IP AWARENESS SCREEN

To include a µC/TCP-IP awareness screen in your µC/Probe workspace, first make sure you enable the statistics and error counters in your µC/TCP-IP configuration declared in **net_cfg.h** as shown in Listing B-1:

```
#define  NET_CTR_CFG_STAT_EN                    DEF_ENABLED

#define  NET_CTR_CFG_ERR_EN                     DEF_ENABLED
```

Listing B-1 **µC/TCP-IP Configuration File: net_cfg.h**

Then make sure you load the ELF file as described in Chapter 3, “Loading an ELF file” on page 16. Then you can go to the **Workspace Explorer** on the right hand side and click on the button **Screens** and select **µC/TCP-IP** Awareness Screen as illustrated in Figure B-9:

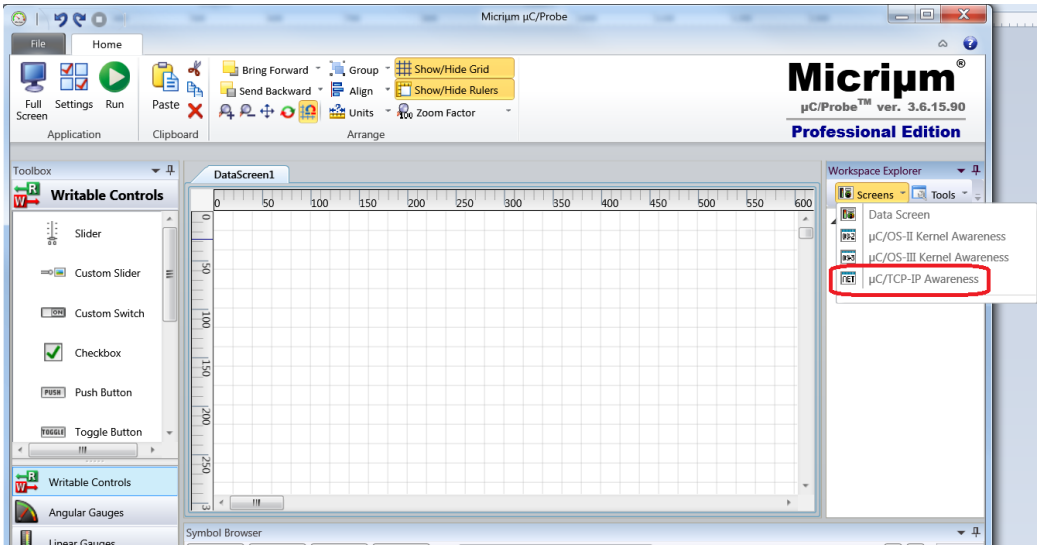



Figure B-9 **µC/TCP-IP Awareness Screens: Adding a Screen**

Appendix

# C

# Terminal Window Control

µC/Probe provides an option to enable debug traces to output the embedded target's activity via any of the communication interfaces supported by µC/Probe. A trace message is displayed in a terminal window control in µC/Probe, by calling a function `ProbeTermTrcPrint()` from your embedded application as illustrated in Figure C-1. Additionally, you can prefix the messages with special tags that µC/Probe will replace with icons that you get to choose.

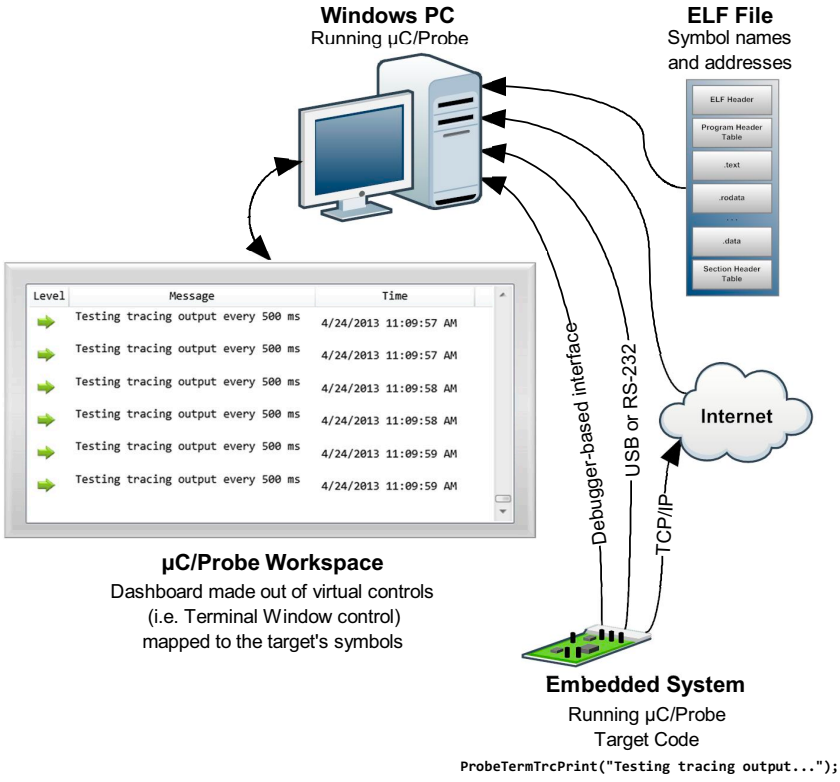



Figure C-1 **Terminal Window Control - Trace Interface**

At the same time, µC/Probe provides the option to enable a command-line interface to the embedded target. A command-line interface allows the user to issue a command to the target from a terminal window control in µC/Probe. Examples of command lines are `ipconfig`, `dir` or whatever command the programmer wants to implement in the embedded target.

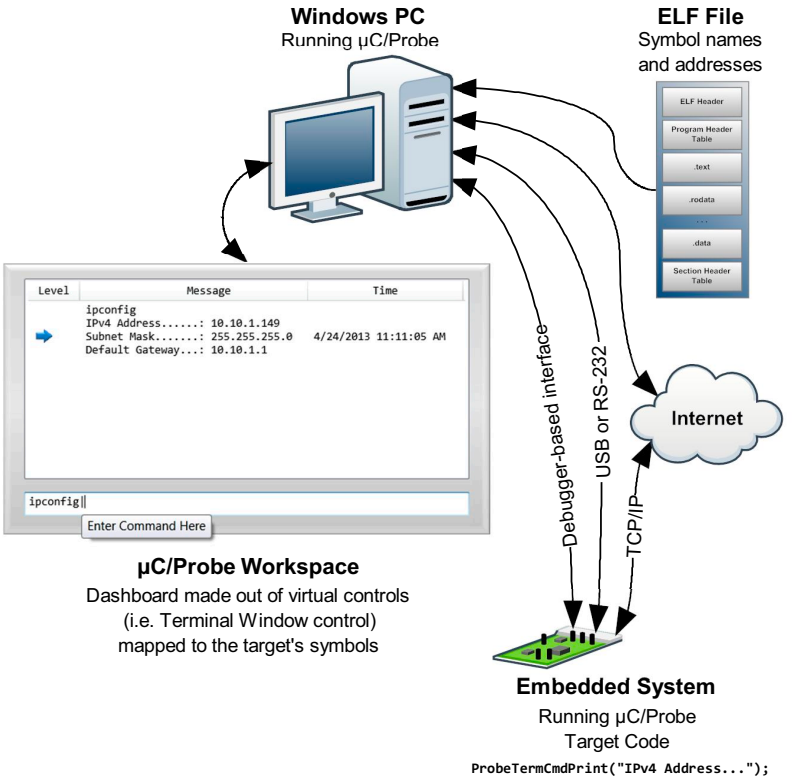



Figure C-2 **Terminal Window Control - Command Line Interface**

This appendix will introduce you to the debug trace and command-line tools available in µC/Probe. It will show you how to configure the control in µC/Probe. More information on the Terminal Window control such as how to include it in your embedded target code and make use of it are in the target version of the µC/Probe manual.

## C-1 TERMINAL WINDOW CONTROL CONFIGURATION

The terminal window control is found in the miscellaneous category of µC/Probe's toolbox. Once you drag and drop an instance of this control onto the data screen, you do not need to associate it with any of the embedded target's symbols from the symbol browser, as this is done automatically, assuming you have included the required target code to support terminal window as described in the target version of the µC/Probe manual.

You can access the properties tool bar by moving the mouse over the terminal window control. The tool bar shown in Figure C-3 appears for you to select between one of the two configuration categories:

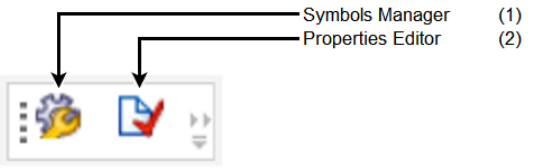



Figure C-3 **Terminal Window Control Toolbar**

FC-3(1) The Symbols Manager is common for all virtual controls and indicators, see Chapter 8, "Associating Symbols to Virtual Controls and Indicators" on page 37 for more information on the Symbols Manager.

FC-3(2) The Properties Editor is similar among most of the virtual controls and indicators and the next sections will describe how to use the Properties Editor.

## C-2 PROPERTIES EDITOR

The properties editor for the terminal window control is shown in Figure C-4:

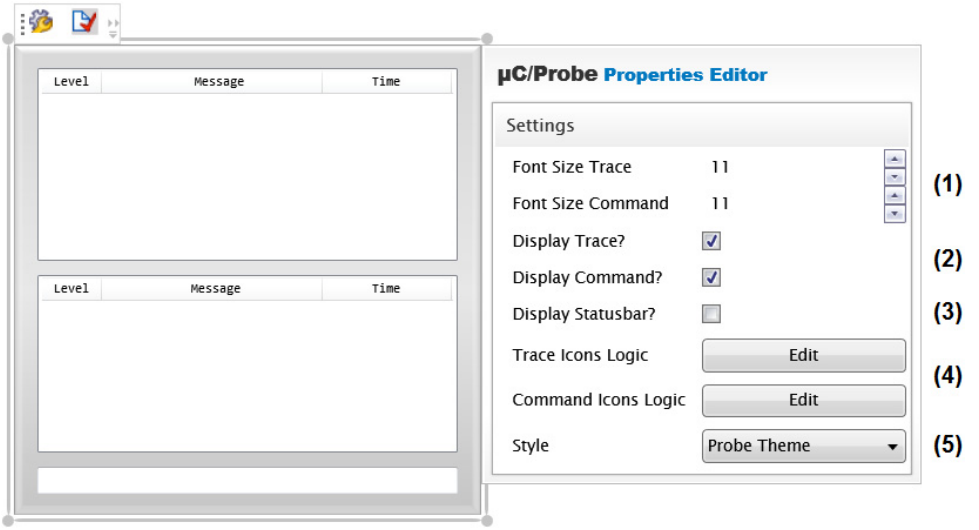



Figure C-4 **Terminal Window Control Properties Editor**

FC-4(1) You can change the font size for each panel.

FC-4(2) You can hide one of the interfaces.

FC-4(3) The terminal window control has a status bar that allows you to see the communication status.

FC-4(4) The icons mapping interface allows you to configure an icon to be displayed whenever a keyword is found in the message back from the target. This is useful if you want to bring more attention to a set of messages, such as warnings or errors.

FC-4(5) The terminal window control is also available in a high contrast theme.

Appendix

# D

# µC/Trace Triggers Control

µC/Trace is a runtime diagnostics tool for embedded software systems based on µC/OS-III. µC/Trace gives developers an unprecedented insight into the runtime behavior, which allows for reduced troubleshooting time and improved software quality, performance and reliability. Complex software problems which otherwise may require many hours or days to solve, can with µC/Trace be understood quickly, often in a tenth of the time otherwise required. This saves you many hours of troubleshooting time. Moreover, the increased software quality resulting from using µC/Trace can reduce the risk of defective software releases, causing damaged customer relations.

The insight provided by µC/Trace also allows you to find opportunities for optimizing your software. You might have unnecessary resource conflicts in your software, which are "low hanging fruit" for optimization and where a minor change can give a significant improvement in real-time responsiveness and user-perceived performance. By using µC/Trace, software developers can reduce their troubleshooting time and thereby get more time for developing new valuable features. This means a general increase in development efficiency and a better ability to deliver high-quality embedded software within budget.

µC/Trace provides more than 20 interconnected views of the runtime behavior, including task scheduling and timing, interrupts, interaction between tasks, as well as user events generated from your application as shown in Figure D-1. µC/Trace can be used side-by-side with a traditional debugger and complements the debugger view with a higher level perspective, ideal for understanding the complex errors where a debugger's perspective is too narrow.

µC/Trace is more than just a viewer. It contains several advanced analyses developed since 2004, that helps you faster comprehend the trace data. For instance, it connects related events, which allows you to follow messages between tasks and to find the event that triggers a particular task instance. Moreover, it provides various higher level views such as the Communication Flow graph and the CPU load graph, which make it easier to find anomalies in a trace.

µC/Trace does not depend on additional trace hardware, which means that it can be used in deployed systems to capture rare errors which otherwise are hard to reproduce.

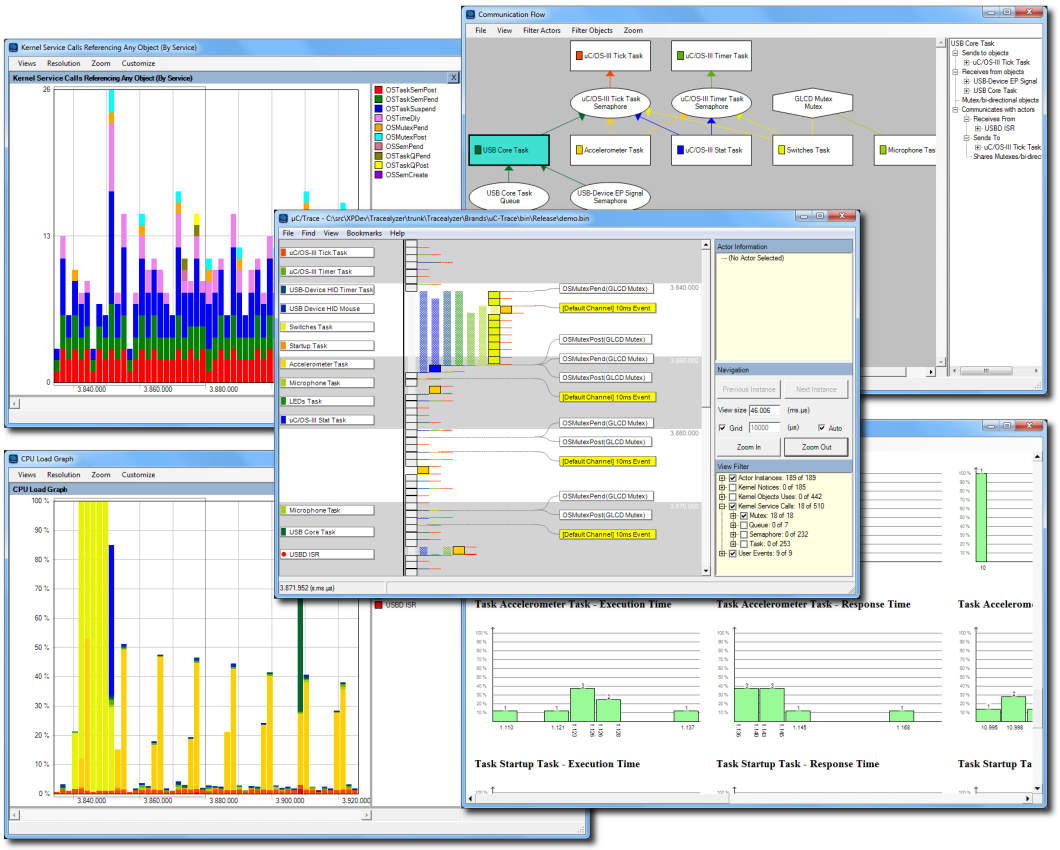

Communication Flow
Kernel Service Calls Referencing Any Object (By Service)
CPU Load Graph
Task Accelerometer Task - Execution Time
Task Accelerometer Task - Response Time
Task Startup Task - Execution Time
Task Startup Task - Response Time

Figure D-1 **µC/Trace Analyzer Windows**

The µC/Trace solution consists of three parts:

- The PC application (µC/Trace), used to analyze the recordings as shown in Figure D-1.
- A trace recorder library that integrates with µC/OS-III, provided in C source code.
- Optionally, µC/Probe can be used for the target system connection.

The PC application µC/Trace has been developed for Microsoft Windows.

The trace recorder library stores the event data in a RAM buffer, which is uploaded on request to the host PC using your existing debugger connection or µC/Probe.

And finally, you can use µC/Probe and a special control designed for µC/Trace called µC/Trace Trigger Control, to trigger a recording and launch the µC/Trace analyzer. The µC/Trace Trigger Control is shown in Figure D-2:

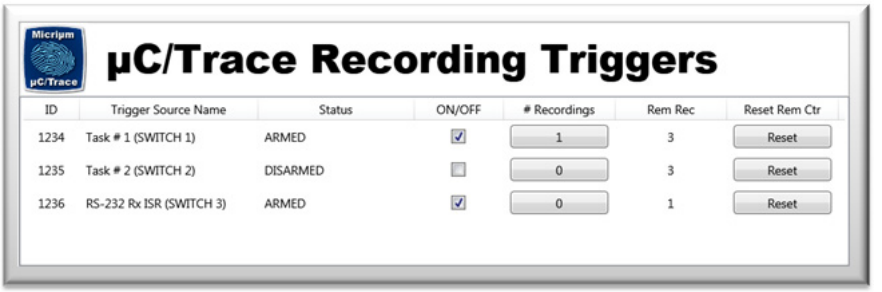



Figure D-2 **µC/Trace Trigger Control**

For more information on µC/Trace, go online to http://micrium.com/tools/uctrace

# Appendix E

# Spreadsheet Control

Microsoft® Excel® is a very widely used spreadsheet application developed by the Microsoft® Corporation. It features calculation and graphing tools among other features that now you can embed in your µC/Probe data screens thanks to a technology offered by Microsoft® called *Automation*.

Automation to Excel® allows you to programmatically perform actions such as creating a new workbook, adding data to the workbook, or creating charts. Virtually, all of the actions that you can perform manually through the user interface can also be performed programmatically by using automation.

µC/Probe makes use of automation to allow you to create a workbook, map the spreadsheet cells to your embedded target symbols and make use of all the features Excel® has to offer.

This appendix will show you how to drag-and-drop an instance of Excel® into a µC/Probe data screen and how to associate your embedded target symbols to the spreadsheet's cells.

*Microsoft®, Excel® and Windows® are either registered trademarks or trademarks of Microsoft® Corporation in the United States and/or other countries. The use of Microsoft® Excel® automation features by µC/Probe does not imply that Micriμm and/or µC/Probe have any Microsoft® affiliation, sponsorship, endorsement, certification, or approval.*

## E-1 ADDING AN INSTANCE OF THE SPREADSHEET CONTROL

The Spreadsheet Control is only available on the Professional Edition of µC/Probe. Additionally, you need to have Microsoft® Excel® version 2003 or newer installed on your Windows® PC.

In order to add an instance of Excel® into a Data Screen, go to the µC/Probe toolbox in the *Advanced* controls category and drag-and-drop the icon labeled *Spreadsheet* into a data screen as illustrated in Figure E-1:

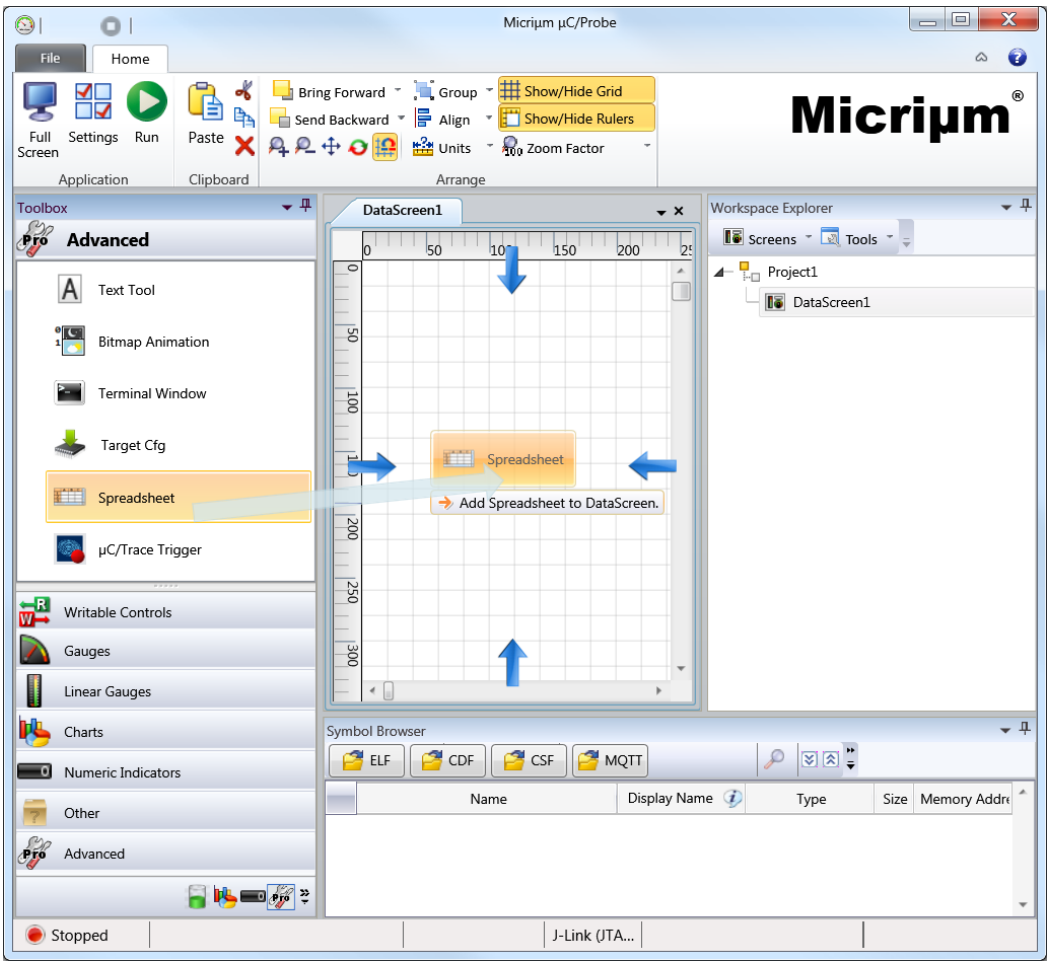



Figure E-1 **Adding an Instance of the Spreadsheet Control**

## E-2 THE SPREADSHEET CONTROL PANEL

Once you have successfully added an instance of Excel® into a data screen, not only a new Microsoft Excel workbook will be launched but also the *Spreadsheet Control Panel* within µC/Probe shown in Figure E-2 will appear. This control panel will allow you to perform the functions indicated in Figure E-2:

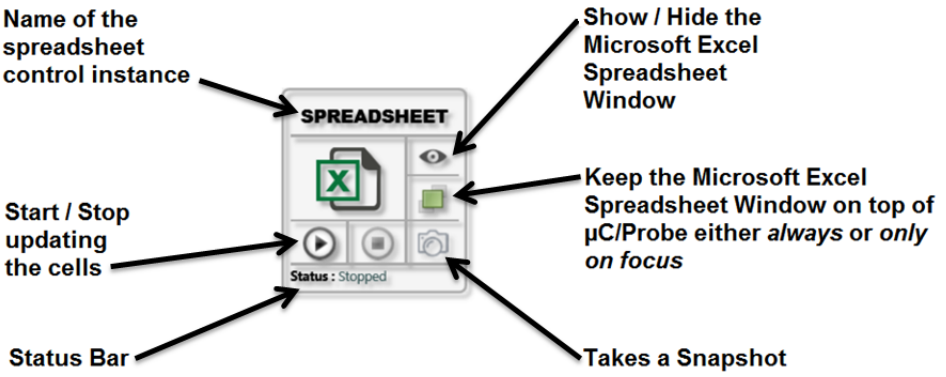

Name of the spreadsheet control instance
SPREADSHEET
Show / Hide the Microsoft Excel Spreadsheet Window
Keep the Microsoft Excel Spreadsheet Window on top of µC/Probe either *always* or *only on focus*
Start / Stop updating the cells
Status : Stopped
Status Bar
Takes a Snapshot

Figure E-2 **Spreadsheet Control Panel**

## E-3 CONFIGURING THE SPREADSHEET

The next step is to configure the newly created Microsoft Excel Spreadsheet. In essence, it is time to associate your embedded target symbols from the *Symbol Browser* to any cell in the spreadsheet as illustrated in Figure E-3:

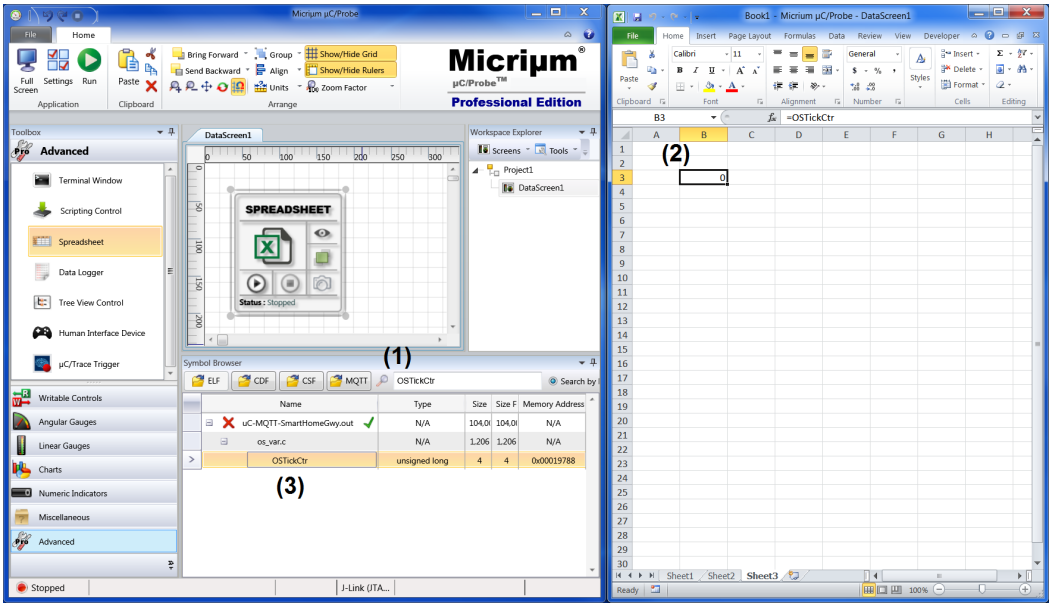



Figure E-3 **Configuring the Spreadsheet**

FE-3(1) You open a symbols file (i.e. ELF file) and browse through it as described in Chapter 3, “µC/Probe Symbol Browser” on page 15.

FE-3(2) Select the Cell in Microsoft Excel that you want to configure.

FE-3(3) Go back to the *Symbol Browser* and double-click over the symbol you want to configure.

## E-3-1 CONFIGURING THE SPREADSHEET WITH MORE COMPLEX DATA TYPES

The previous section showed how to configure the spreadsheet by first selecting the cell, then selecting the symbol from the symbol browser and finally double-clicking over the symbol. If said symbol is one of the basic data types such as an `int`, `float` or `char` then there is really not much more to it. The cell will display the value of said symbol during run-time period.

However, if the symbol you select is rather complex such as an array or data structure, then an additional dialog window will be displayed when you double-click over the symbol. The following sections show you examples of adding an array and a data structure.

### ARRAYS

If you associate a cell with an array the dialog shown in Figure E-4 will be presented:

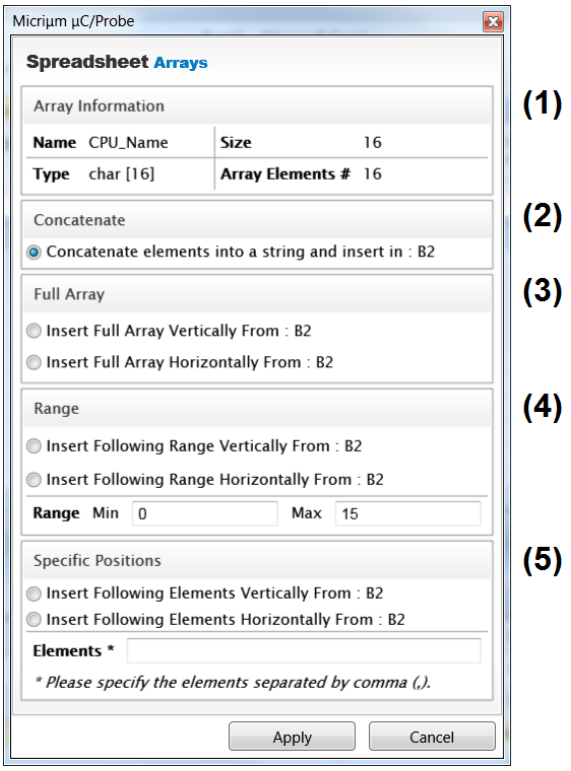



Figure E-4 **Spreadsheet: Arrays**

FE-4(1) The section at the top present information about the array (i.e. Name, Data Type and Size).

FE-4(2) This is the default mode when the data type is string. It tells µC/Probe to include the array as a representation of a string. Each element in the arry will be concatenated and placed inside one single cell.

FE-4(3) The Full Array mode, means that each element in the array will occupy a cell. The first element will be placed in the cell you selected and the rest of element will be added in the next cells either horizontally or vertically.

FE-4(4) The Range mode is similar to the previous one, except that you also get the opportunity to specify a range of elements in the array.

FE-4(5) The last mode is even more flexible as you can specify which elements go into each cell. You simply configure the array indexes you want included in a comma separated list. For example if you just want to include 4 elements: 1,3,6,9.

### DATA STRUCTURES

When you add a data structure you will not be presented with any special dialog windows. µC/Probe will simply create a table in Excel as illustrated in Figure E-5:

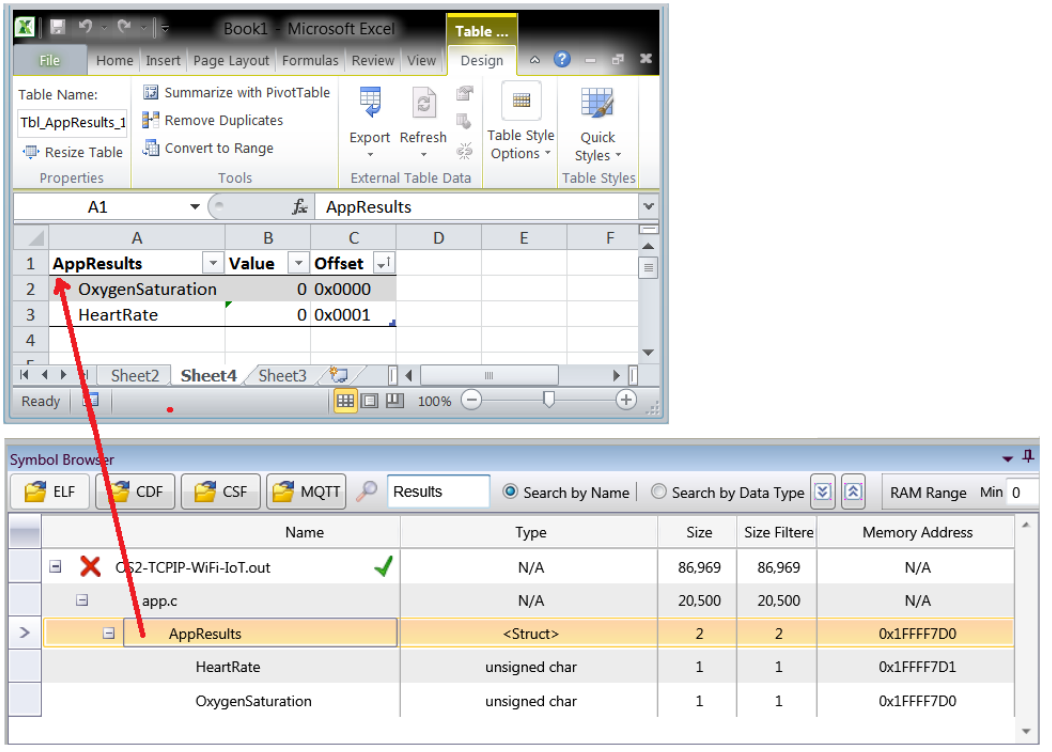



Figure E-5 **Spreadsheets: Data Structures**

## E-4 OTHER FEATURES

## E-4-1 INTELLISENSE

The previous section E-3 “Configuring the Spreadsheet” on page 123 showed you how to configure the spreadsheet by adding one embedded target symbol at a time. As another option you can add all the symbols declared in a single C file at once. You simply go to the symbol browser and instead of selecting a symbol, you select the parent node which is the name of the C file and double click on it. That in turn will include all the symbols in the

spreadsheet's list of names. This way, you can type in a few letters of the symbol you want to add in a cell and Excel will show you a list of options. For example Figure E-6 shows the Excel spreadsheet after doing a double-click over the file `app.c` in µC/Probe's Symbol Browser. Notice that the list of options when you type in `=App` is made with all the variables declared in `app.c` that start with `App`. With this feature, you can use the variable names even as part of Excel formulas.

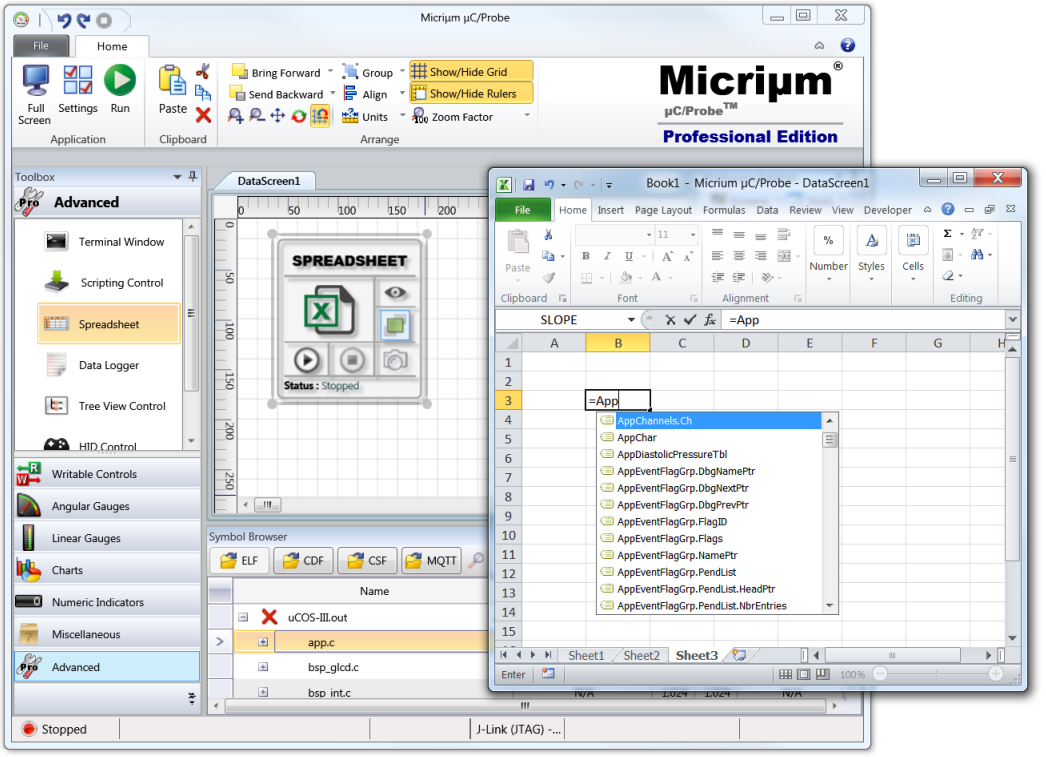



Figure E-6 **Intellisense**

## E-4-2 FORMULAS

Figure E-7 shows you other features:

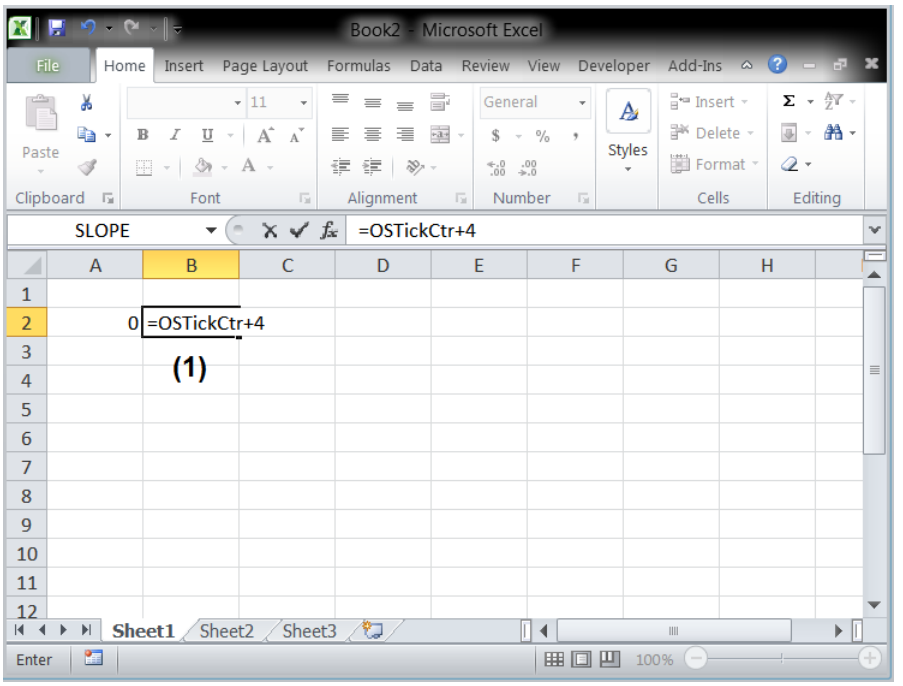



Figure E-7 **Other Features**

FE-7(1) Excel® formulas start by typing in the equal sign in the cell where you want the formula result to appear. As soon as you type in the equal sign, start entering the first few letters of the name of the symbol you want to use in the expression, and for your convenience, Excel® will show you a list of the symbol names you have previously added to the spreadsheet.

When you click on a cell containing a formula in Microsoft® Excel®, the formula always appears in the formula bar located above the column letters.

FE-7(2) You can import and export the spreadsheet along with the embedded target symbols mapping in the form of a regular Microsoft® Excel® file (xls).

FE-7(3) Press the button labeled *Delete Spreadsheet* to remove the spreadsheet from the data screen.

## E-5 APPLICATION EXAMPLE

A great way to use µC/Probe and the Spreadsheet Control is to test and calibrate an onboard accelerometer. Imagine your embedded application is reading an accelerometer's X and Y axis and storing them in the global variables `AppAccelX` and `AppAccelY` respectively as shown in Figure E-8:

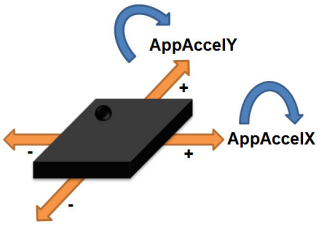



Figure E-8 **Accelerometer**

Very quickly you can add an instance of the spreadsheet control, map two cells to the variables `AppAccelX` and `AppAccelY`, insert a bubble chart from Excel® and there you have a bubble level as shown in Figure E-9:

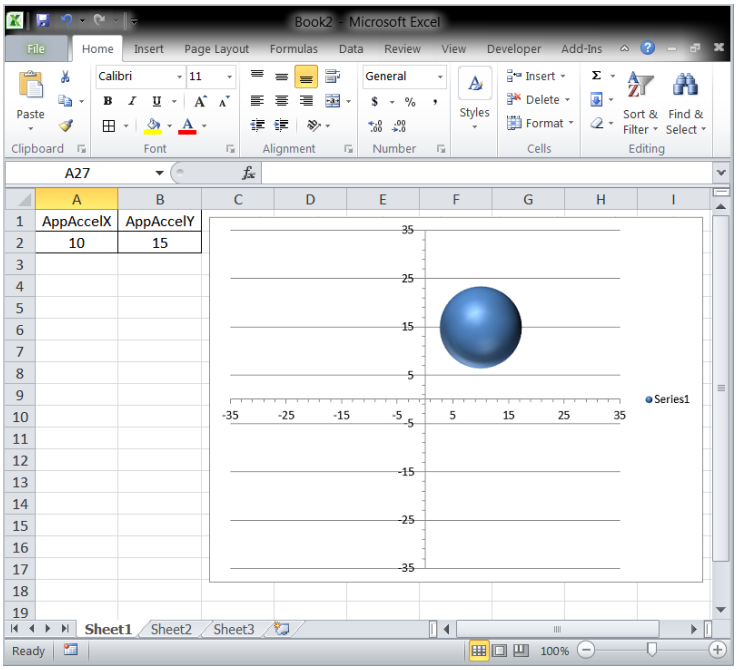



Figure E-9 **Bubble Level Chart**

Appendix

# F

# Scripting Control

The Professional Edition of µC/Probe comes with a control that helps you programmatically read and write your embedded target symbols on the fly.

You write a script in a C style language to read and write your embedded target symbols and this control will execute your script whenever you want.

Use the µC/Probe Scripting Control to create configuration files, test scripts and to automate the execution of any other common tasks which could alternatively be executed manually by a human operator.

## F-1 WRITING A SCRIPT

The µC/Probe Scripting Control supports a programming language that is very similar to C. You write the script as a text file to manipulate variables in two different scopes; the script-side and the embedded target side as described in the following sections.

## F-1-1 SCRIPT-SIDE VARIABLES

You declare a variable on the script-side (host PC) by prefixing it with the keyword `var` or with the data type as shown in Code Listing F-1:

```
var max_ch = 3;                      /* Declare a script-side variable by using the keyword  */
                                     /* 'var' and initialize it before using it.             */

string lcd_part_nbr = "";            /* Alternatively, you can declare script-side variables */
                                     /* by specifying its data type (char, string, short,    */
                                     /* int, uint, long, ulong, float, double, bool, etc.).  */

int    gain = 10;

string filter_type;                  /* Furthermore, when the data type is specified, you do */
                                     /* not require to initialize the variable.              */

if (max_ch == 8) {
    ...
} else {
    ...
}
```

Listing F-1 **Script-Side Variables**

## F-1-2 EMBEDDED TARGET SIDE VARIABLES

The variables on the embedded target side are referenced by prefixing the name of the variable with the dollar sign `$` as shown in the following Code Listing F-2:

```
$AppTimeout   = 100;                 /* Target-side variables are prefixed with the $ sign   */
$AppFrequency =  50;                 /* and they must be present in the target's ELF file.   */

for (int i = 0; i < max_ch; i++) {
    $AppChannels.Ch[i].Gain = gain;
}
```

Listing F-2 **Embedded Target Side Variables**

## F-1-3 FLOW CONTROL STATEMENTS

The µC/Probe Scripting Control provides two styles of flow control; branching and looping.

### BRANCHING

- `if` statement
- `switch/case` statement
- `?` operator

### LOOPING

- `while` loop
- `for` loop
- `do/while` loop

It is your responsibility to ensure the loops have a terminating condition and that the terminating condition can be met. Code Listing F-3 shows an example of using some of these flow control statements:

```
if (max_ch == 8) {
    ...
} else {
    ...
}

switch ($AppSwitches) {
    case 1:
         ...
         break;
}

while ($AppStateCalibrating == true) {
    Sleep("Calibrating", 1000);
}
```

Listing F-3 **Flow Control Example**

## F-1-4 BUILT-IN INSTRUCTIONS

Besides the standard flow control statements previously mentioned, the µC/Probe Scripting Control provides a set of built-in instructions to help you create a better user interface.

Code Listing F-4 shows you how to use the `Sleep()` and `Pause()` built-in instructions.

```
for (int i = 0; i < max_ch; i++) {
    $AppChannels.Ch[i].Gain = 0;
                                        /* The Sleep instruction allows you to delay the script */
                                        /* execution (milliseconds) with a custom message.      */
    Sleep("Reaching Steady-State...", 200);
}

$AppSelfTestStart = true;

Pause("Self-Test in progress...");    /* The Pause instruction allows you to pause the script */
                                        /* execution until you press a button in µC/Probe.      */
if ($AppSelfTestResult < 0) {
    Abort();                           /* The Abort instruction allows you to stop the script  */
                                        /* execution.                                           */
} else {
    ...
}
```

Listing F-4 **Built-in Instructions**

## F-1-5 INCLUDING OTHER SCRIPT FILES

Similar to the directive `#include` in the C language, the µC/Probe Scripting Control allows you to include other script files to help you organize your scripts in modules.

When a script file is included, the code it contains inherits the variable scope of the line on which the include occurs. Any variables available at that line in the calling file will be available within the called file, from that point forward. However, all functions defined in the included file have the global scope.

## F-2 ADDING AN INSTANCE OF THE SCRIPTING CONTROL

To add an instance of the µC/Probe Scripting Control go to the µC/Probe toolbox in the *Advanced* Controls category and drag-and-drop the icon labeled *Scripting* into a data screen as shown in Figure F-1:

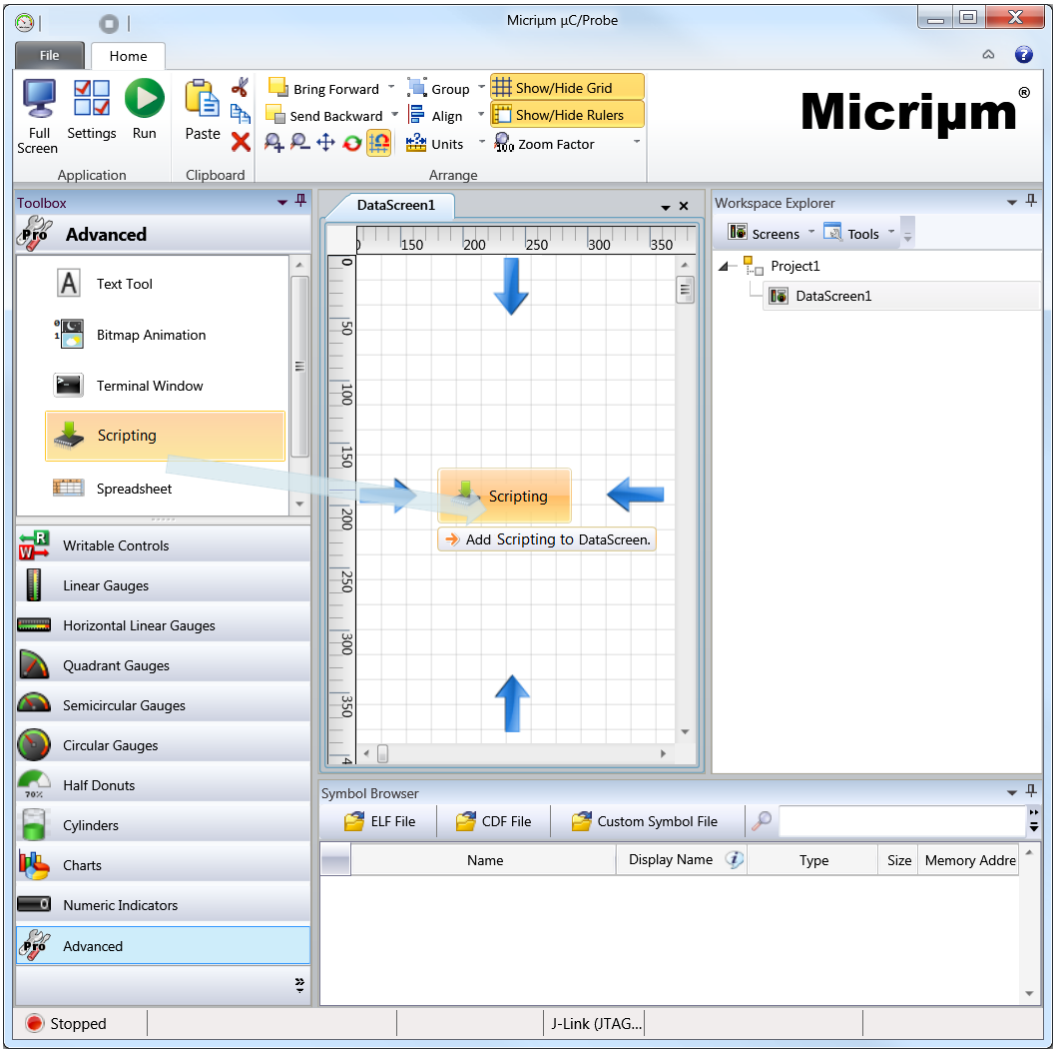



Figure F-1 **Adding an Instance of the Scripting Control**

## F-3 CONFIGURING THE SCRIPTING CONTROL

Once you have successfully added an instance of the Scripting Control into a data screen, you have to specify the path to the script file by making click on the properties editor button, which in turn opens a file dialog for you to specify the location of your script file as shown in Figure F-2:

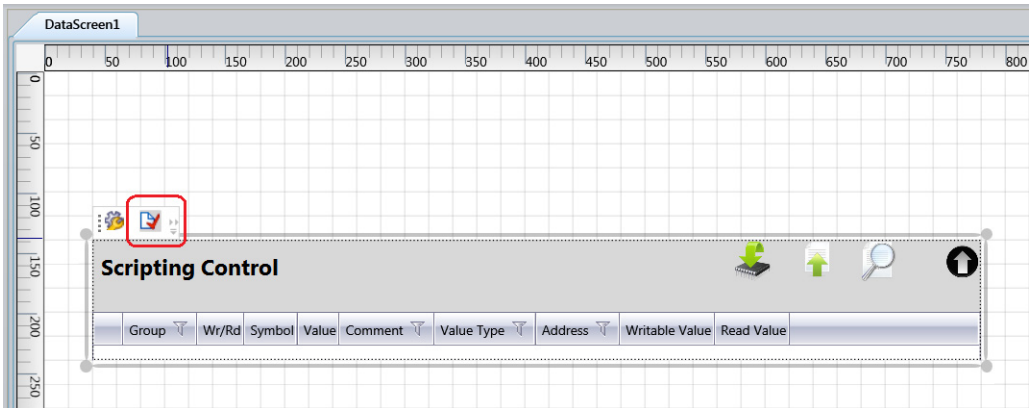



Figure F-2 **Configuring the Scripting Control**

## F-4 EXECUTING THE SCRIPT

Suppose you create a configuration script that not only sets the gain of each channel in your data acquisition system, but also activates a system self test and then evaluates the results.

Code Listing F-5 shows the script for such an example.

```
                                    /* Configure the system.                                */
var max_ch = 3;
int gain   = 10;

for (int i = 0; i < max_ch; i++) {
    $AppChannels.Ch[i].Gain = gain;
}

$AppSelfTestStart = true;           /* Gets the system self test started.                   */

                                    /* The Sleep instruction allows you to delay the script */
                                    /* execution (milliseconds) with a custom message.      */
Sleep("Self-Test in progress...", 5000);

                                    /* Evaluate the self test results.                      */
if ($AppSelfTestErr == 0) {
                                    /* The Pause() instruction allows you to suspend        */
                                    /* execution until you press a button in µC/Probe.      */
    Pause("System Configured OK.");
} else {
    Pause("Unable to Configure the System.");
}
```

Listing F-5 **Configuration Script Example**

Once you configure the Scripting Control with the script in Listing F-5, the control will parse the code and will display each of the instructions the control will execute for you as shown in Figure F-3:

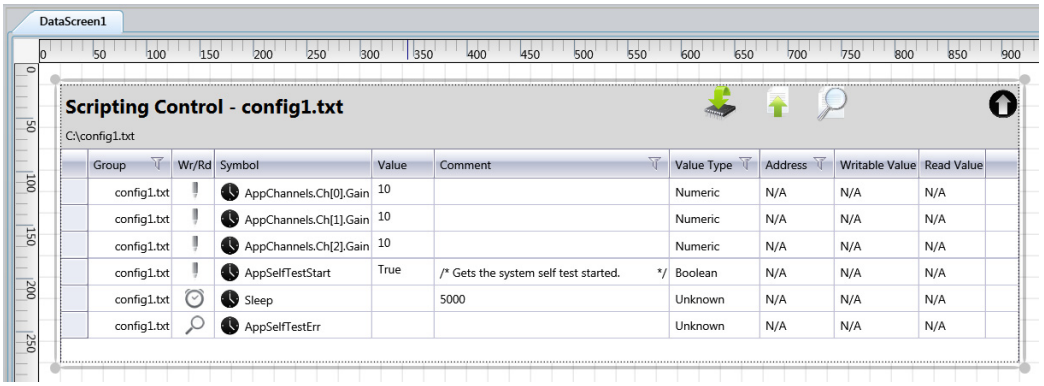



Figure F-3 **Configuration Script Example - Design Time**

When you run µC/Probe, the control will execute your script when you click the button with the chip icon and will display the status of each instruction's execution as shown in Figure F-4:

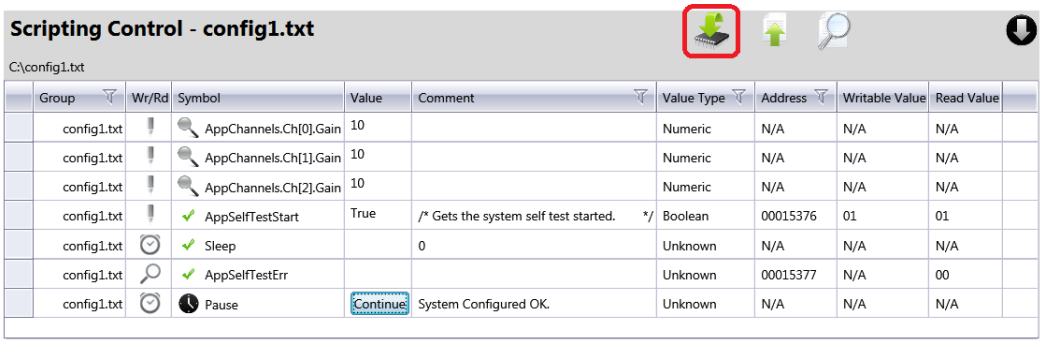

Scripting Control - config1.txt
C:\config1.txt
Group
Wr/Rd
Symbol
Value
Comment
Value Type
Address
Writable Value
Read Value
config1.txt AppChannels.Ch[0].Gain 10 Numeric N/A N/A N/A
config1.txt AppChannels.Ch[1].Gain 10 Numeric N/A N/A N/A
config1.txt AppChannels.Ch[2].Gain 10 Numeric N/A N/A N/A
config1.txt AppSelfTestStart True /* Gets the system self test started. */ Boolean 00015376 01 01
config1.txt Sleep 0 Unknown N/A N/A N/A
config1.txt AppSelfTestErr Unknown 00015377 N/A 00
config1.txt Pause Continue System Configured OK. Unknown N/A N/A N/A

Figure F-4 **Configuration Script Example - Run Time**

Appendix

# G

# Data Logging Control

µC/Probe provides an option to log the values of any variable(s) in your symbols browser to a CSV file. The Data Log Control is part of the **Advanced** category of µC/Probe's toolbox.

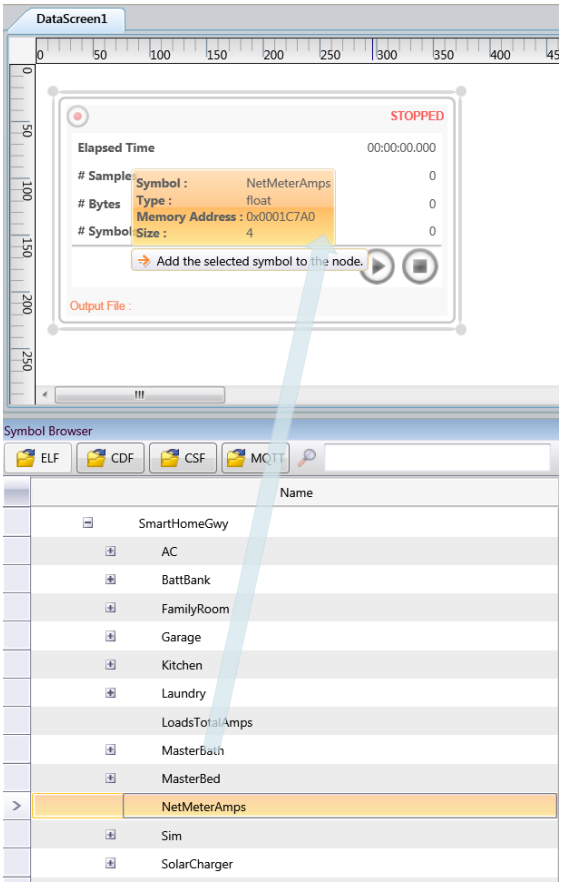



Figure G-1 **Data Log Control**

Figure G-1 illustrates how to log a variable called `NetMeterAmps`. All you have to do is drag and drop an instance of the Data Log Control from the Advanced category in your toolbox and then search the variable you want to data log in the Symbol Browser. You add the variable to the data log by dragging and dropping it onto the Data Log control. You can add as many variables as you want and they will be stored in a CSV file, one column per variable.

You can configure the Data Log Control from the Properties Editor as shown in Figure G-2:

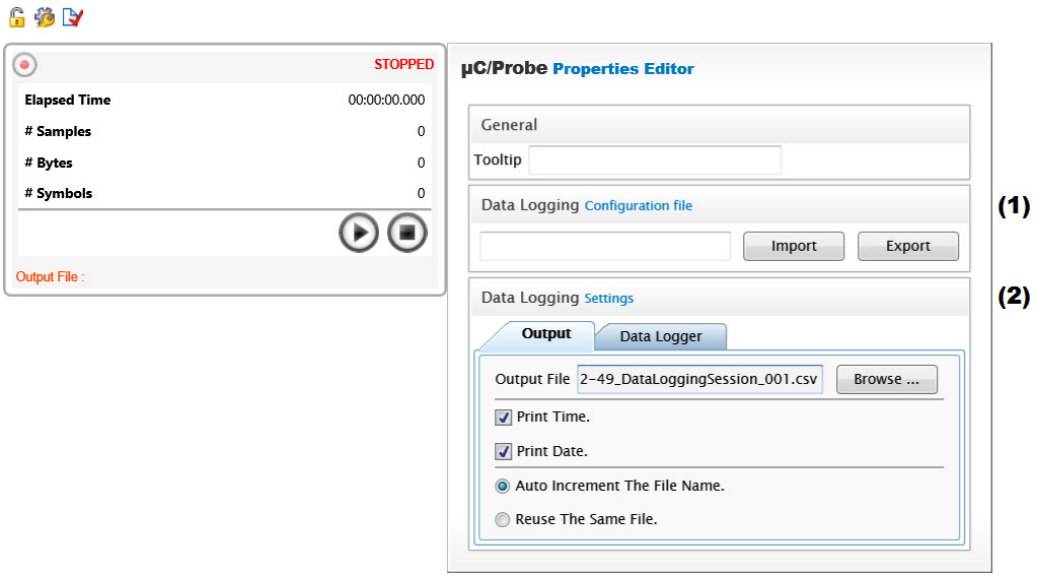
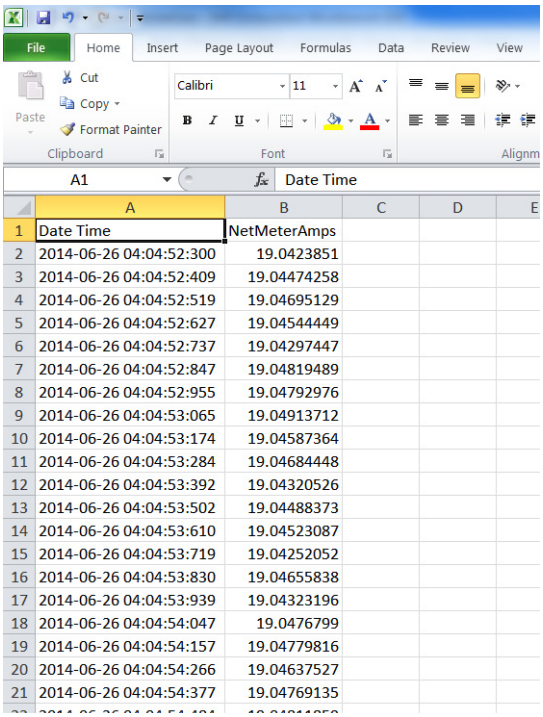



Figure G-2 **Data Log Control Properties Editor**

FG-2(1) You can either **Import** a Data Log Configuration file from a past logging session or you can **Export** your current configuration to a file.

FG-2(2) The Data Logging Settings panel consists of two tabs; The **Output** tab and the **Data Logger** tab. From the **Output** tab you can configure the output file. You can specify the path and name of the output file along with other settings such as the timestamps and whether or not reusing the same file or create a new one by using an auto-increment number as part of the file name. By default the output files are stored in the µC/Probe installation directory in the subfolder `DataLogging`.

During run-time, the value of `NetMeterAmps` will be logged in the CSV file as shown in Figure G-3:




| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Date Time | NetMeterAmps | | | |
| 2 | 2014-06-26 04:04:52:300 | 19.0423851 | | | |
| 3 | 2014-06-26 04:04:52:409 | 19.04474258 | | | |
| 4 | 2014-06-26 04:04:52:519 | 19.04695129 | | | |
| 5 | 2014-06-26 04:04:52:627 | 19.04544449 | | | |
| 6 | 2014-06-26 04:04:52:737 | 19.04297447 | | | |
| 7 | 2014-06-26 04:04:52:847 | 19.04819489 | | | |
| 8 | 2014-06-26 04:04:52:955 | 19.04792976 | | | |
| 9 | 2014-06-26 04:04:53:065 | 19.04913712 | | | |
| 10 | 2014-06-26 04:04:53:174 | 19.04587364 | | | |
| 11 | 2014-06-26 04:04:53:284 | 19.04684448 | | | |
| 12 | 2014-06-26 04:04:53:392 | 19.04320526 | | | |
| 13 | 2014-06-26 04:04:53:502 | 19.04488373 | | | |
| 14 | 2014-06-26 04:04:53:610 | 19.04523087 | | | |
| 15 | 2014-06-26 04:04:53:719 | 19.04252052 | | | |
| 16 | 2014-06-26 04:04:53:830 | 19.04655838 | | | |
| 17 | 2014-06-26 04:04:53:939 | 19.04323196 | | | |
| 18 | 2014-06-26 04:04:54:047 | 19.0476799 | | | |
| 19 | 2014-06-26 04:04:54:157 | 19.04779816 | | | |
| 20 | 2014-06-26 04:04:54:266 | 19.04637527 | | | |
| 21 | 2014-06-26 04:04:54:377 | 19.04769135 | | | |

Figure G-3 **Data Log Output File (CSV format)**

You can suspend or stop the data logging process by using the buttons in the status screen shown in Figure G-4

Figure G-4 **Data Log Control During Run-Time**

Additionally, you can configure **Start** and **Stop** conditions to trigger the data logging process. For example, Figure G-5 illustrates how to configure the Data Logger to Start logging when the value of `NetMeterAmps` is between 20 and 50 amps.

The sampling period can also be configured from the same screen in terms of hours, minutes, seconds and milliseconds

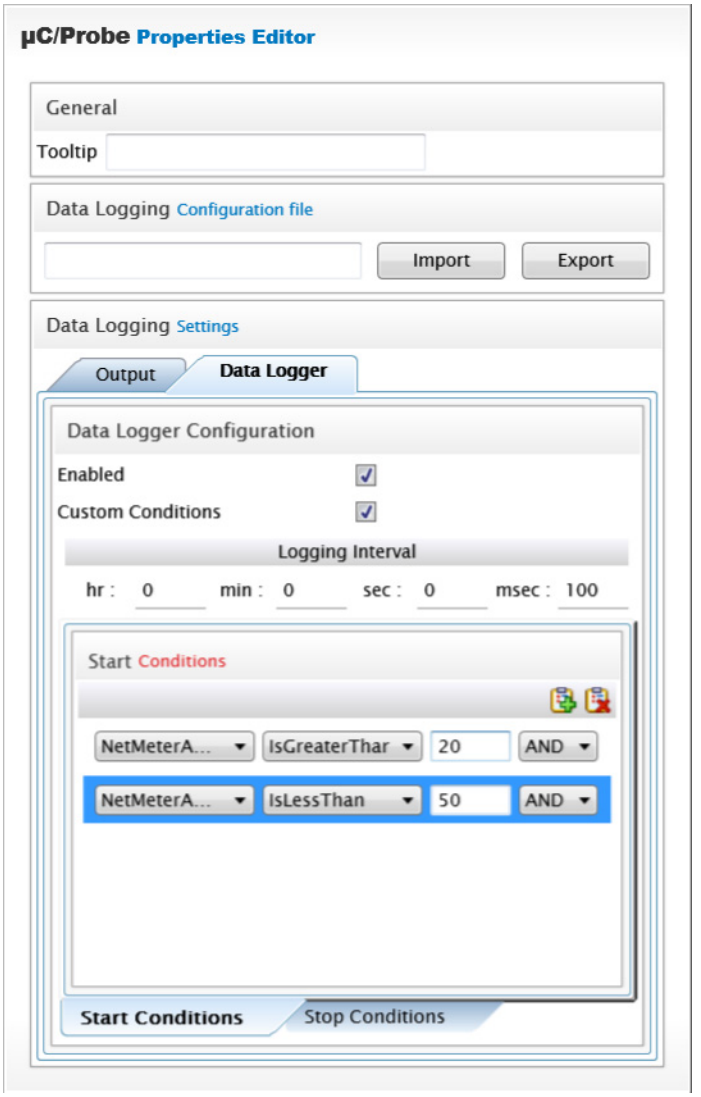



Figure G-5 **Data Logger Start and Stop Conditions**

Appendix

# H

# Human Machine Interface (HID) Control

µC/Probe allows you to use a USB HID control such as a gamepad, joystick or steering wheel to control your embedded target. The HID Control is part of the **Advanced** category of µC/Probe's toolbox.

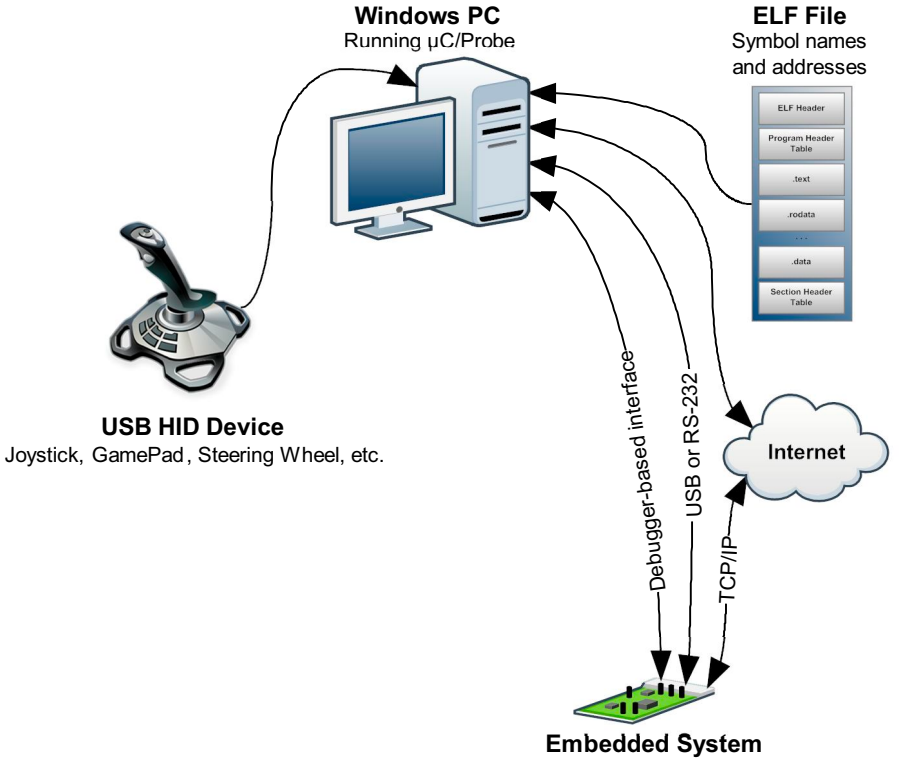



Figure H-1 **HID Control Block Diagram**

You simply declare in your embedded target the variables that will store the output from your HID device.

For example, if your HID device is a Joystick, then you would declare variables such as:

- AppJoystickButton1
- AppJoystickButton2
- AppJoystickButton3
- AppJoystickButtonX
- AppJoystickButtonY

Then you drag and drop an instance of the HID control onto your Data Screen and start associating the embedded variables to the control as shown in Figure H-2:

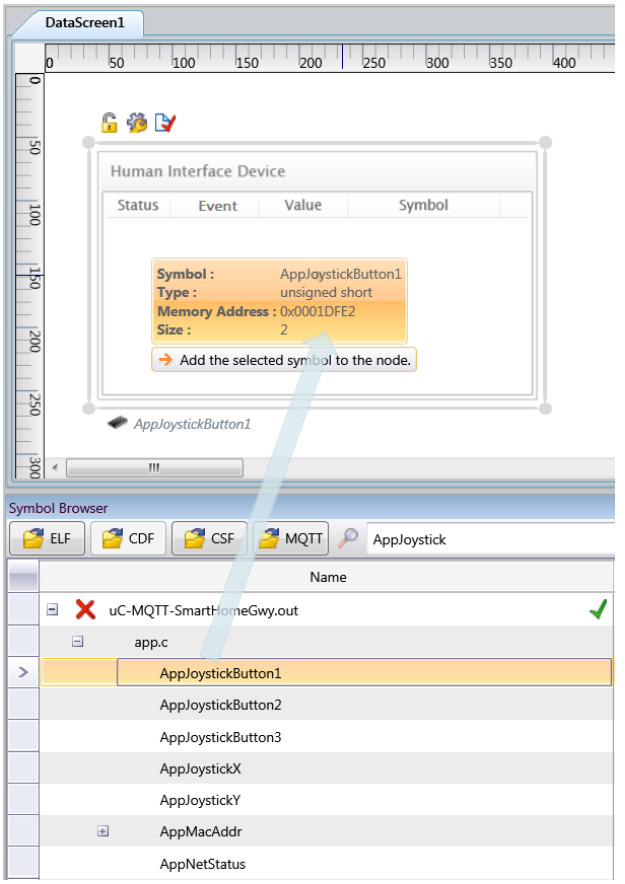



Figure H-2 **Symbol Browser and HID Control**

The next step is to configure each possible event from the HID device and map it to a unique embedded target symbol. You first open the HID Control's Properties Editor and select your HID device as shown in Figure H-3:

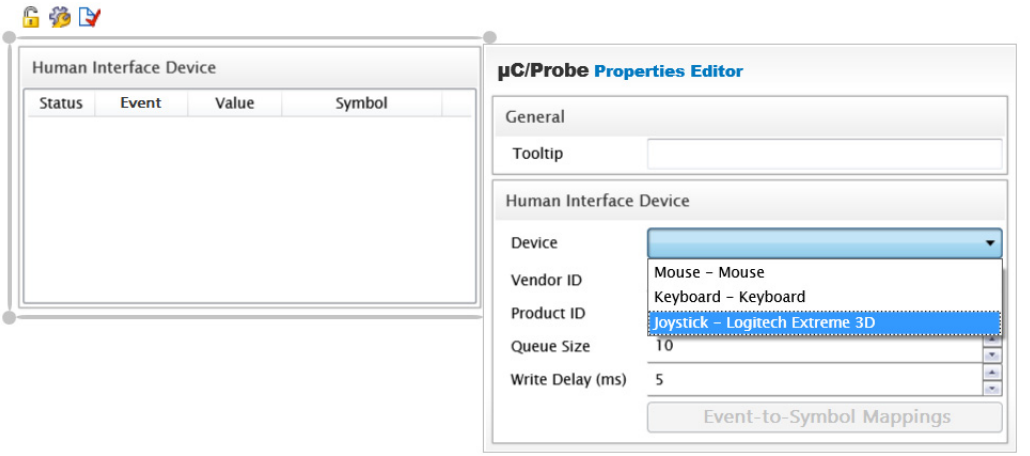



Figure H-3 **HID Control Properties Editor**

Once you select your HID Device, the button labeled as **Event-to-Symbol Mappings** will be enabled and you can proceed to map each event to an embedded target symbol. As you move the joystick, µC/Probe will catch all the possible events and create a new option to configure a mapping as shown in Figure H-4:

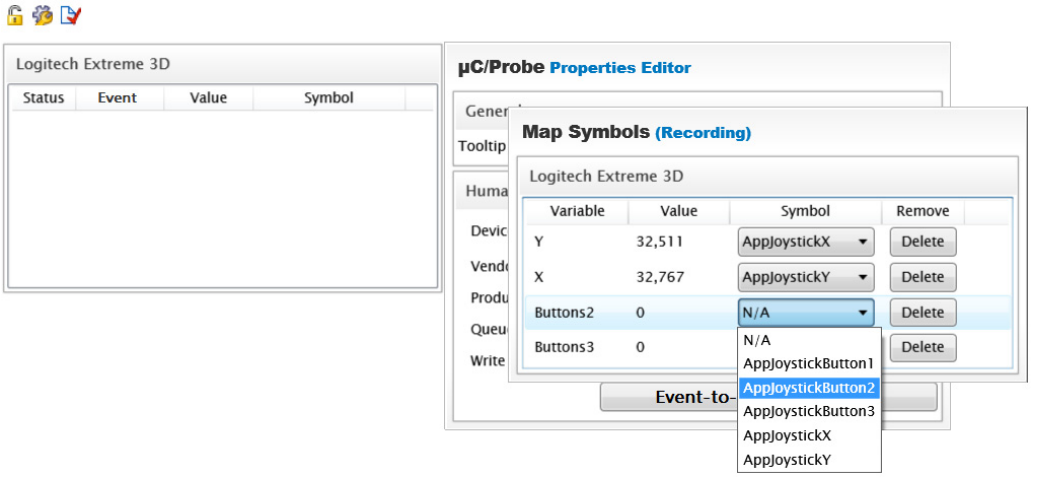



Figure H-4 **HID Control Event-to-Symbol Mappings**

During run-time µC/Probe displays the status of your HID Device with the table shown in Figure H-5. The LED remains green during idle time and turns red once the event is caught. At each event the value is written to the associated target symbol.

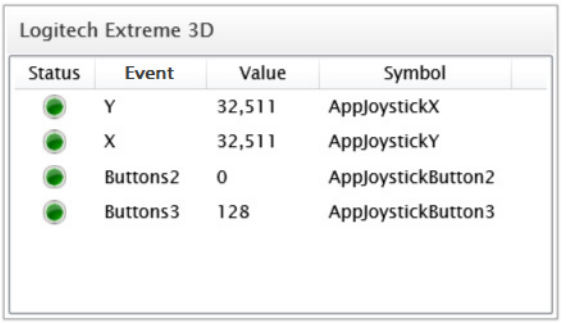



Figure H-5 **HID Control Status**

# Appendix

# Licensing

The Educational Edition of µC/Probe is freely available for students, teachers, and academic organizations. You can purchase µC/Probe for your personally owned computer or those owned by your employer by either a permanent license or a subscription based license as follows:

- Yearly Subscription License

  Our e-commerce partner FastSpring will bill you automatically each year and you may cancel the subscription at any point, no questions asked.

- Permanent License

  Our e-commerce partner FastSpring will bill you only once and you will own the license for an unlimited period of time.

*Note: Keep in mind that all µC/Probe sales are final and non-refundable. The Educational Edition of µC/Probe is available for free to enable you to "try before you buy".*

*For example, if you purchase a yearly subscription and wish to cancel the subscription after a couple of months, we will cancel your subscription and any future billing. However, we will not be able to make any partial refunds and you would still be charged for the first year's subscription.*

## I-1 ORDERING

If you decide to purchase a license of µC/Probe you can go to our online store at:

http://micrium.com/tools/ucprobe/buy

The table below summarizes the main differences among the different editions of µC/Probe:

| **Feature** | **Educational Edition** | **Basic Edition** | **Professional Edition** |
|---|---|---|---|
| Design Mode | x | x | x |
| Run-Time Mode (timeout in minutes) | x (1) | x (no-timeout) | x (no-timeout) |
| Maximum Number of Data Screens | 1 | unlimited | unlimited |
| Maximum Number of Gauge Styles | 5 | unlimited | unlimited |
| Maximum Number of Numeric Indicator Styles | 3 | unlimited | unlimited |
| Thermometer | x | x | x |
| Cylinder Indicators | x | x | x |
| Button Controls | x | x | x |
| Slider Controls | x | x | x |
| Bit Control | x | x | x |
| Marker Chart | x | x | x |
| Line Chart | x | x | x |
| Area Chart | x | x | x |
| Scatter X-Y Chart | | | x |
| µC/OS-II and µC/OS-III Kernel and µC/TCP-IP Awareness | x | x | x |
| Terminal Window Control | | | x |
| Scripting Control | | | x |
| Microsoft® Excel® Bridge | | | x |
| µC/Trace Trigger Control | | | x |
| Import/Export Data Screens | | x | x |
| Numeric Up/Down Control | | | x |
| Textbox Control | | | x |
| Data Log Control | | | x |
| Tree View Control | | | x |
| Radio Buttons Control | | | x |
| HID Control | | | x |

Table I-1 **µC/Probe Editions Comparison Table**

## I-2 ACTIVATING

Once you place an order on our online store you will receive an e-mail message with your license key.

To activate your copy of µC/Probe you need Internet access to validate your license key. If your internal network uses a proxy server to connect to the Internet, then you will need to configure µC/Probe to use your proxy server. To do so, click *File -> Settings -> Host Internet Access* and provide your Proxy server settings in a window similar to the one shown below:

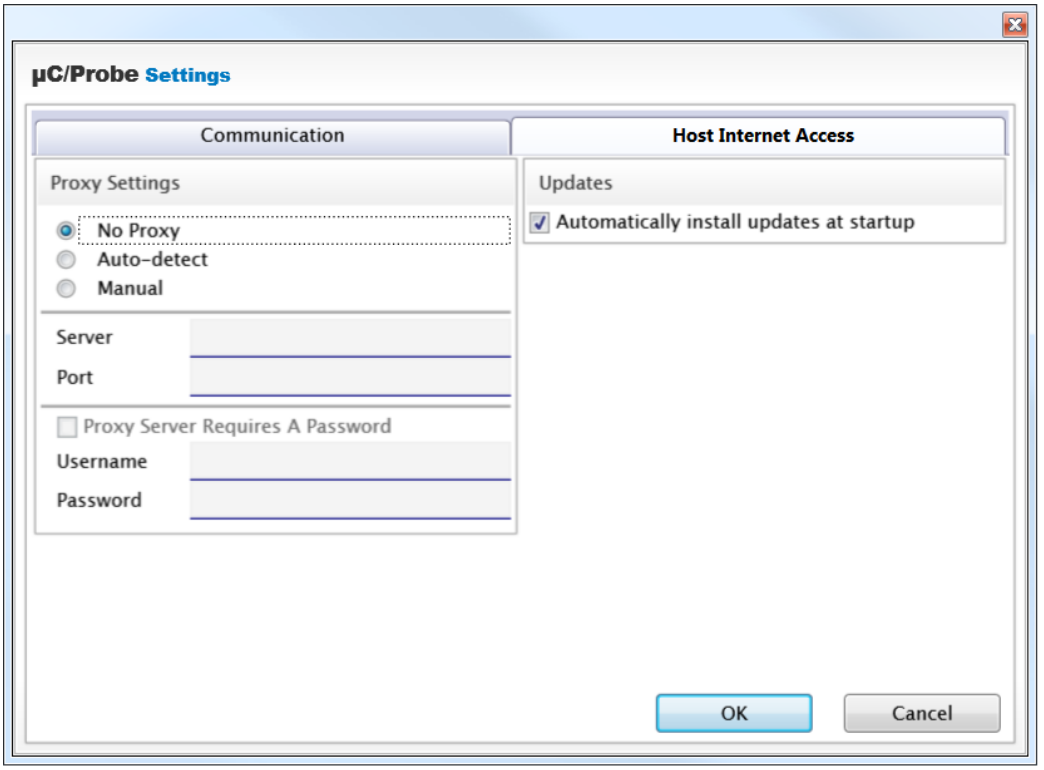



Figure I-1 **Proxy Server Settings**

Once you have verified that your Windows PC has Internet access, click *File -> Activation* and a window similar to the one shown below will be displayed:

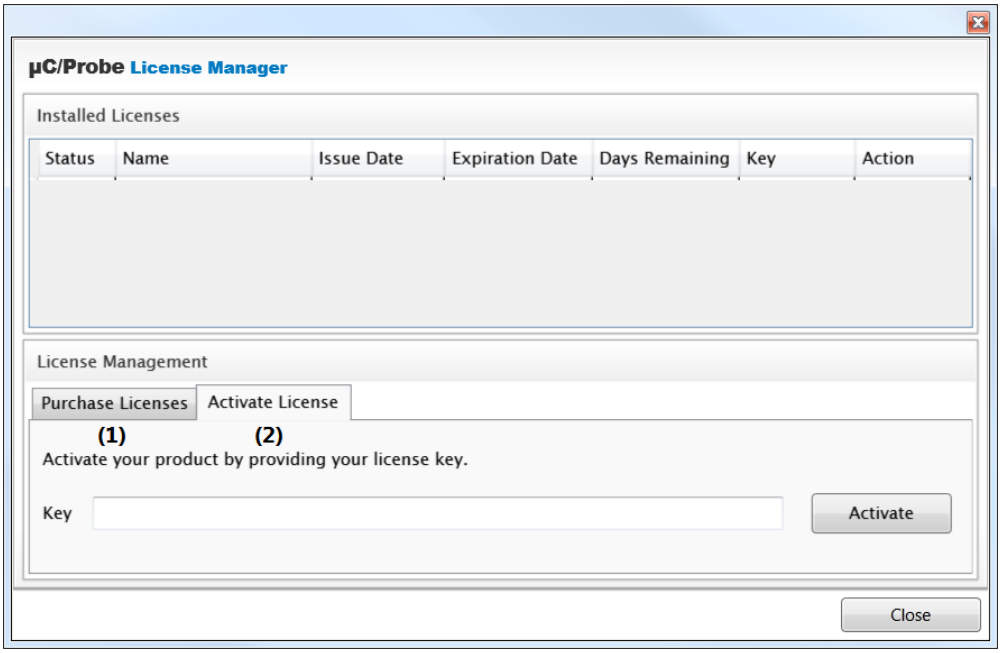



Figure I-2 **License Manager**

FI-2(1) Use this tab to go online and purchase a license of µC/Probe.

FI-2(2) Use this tab to activate a license key and node-lock it to your computer. All you need to do is copy and paste the license key from the e-mail message you received and press the button *Activate*.

## I-2-1

Please contact us for further information about pricing, ordering options, license activation or cancelling a subscription at:

Micriμm
1290 Weston Road, Suite 306
Weston, FL 33326

+1 954 217 2036
+1 954 217 2037 (FAX)

E-Mail : sales@micrium.com
Website : www.micrium.com

Appendix

# J

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- Légaré Christian. *µC/TCP-IP The Embedded Protocol Stack*. Micriµm Press, 2011.

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